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Issue at a Glance

Field Testing Industrial Engines. Oscilloscope, part of Sperry Rand engine analyzer, monitors operation of industrial reciprocating engine at a natural-gas pipeline pumping station. Engine shutdown is not required. See p 68 ..... COVER

Business Briefs ..... p 7

Electronics Newsletter	7	Military Electronics	14
Figures of the Week	7	Labs Pushing Intermetallics	14
Use Electronics to Sort	8	Financial Roundup	16
Polaris Telemeter	8	Sound Cleans Surgical Tools	16
Transistor Output Up, Prices Down	8	Aircraft A-Power Program Widens	16
Satellite's Eye Needs Tv Retina	8	Phototube Control Sets Printing	18
Washington Outlook	12	Gnat Gyros for Small Missiles	18
A-Plant Control Bill $1.9 Million	12	Meetings Ahead	18

Radio Waves Power Transistor Circuits. Energy radiated from remote sources used to power low-drain transistor circuits ..... p 63
By L. R. Crump

Squelch Circuit Mutes Magnetic Tape Echoes. Print-through echoes are killed by qave circuit while local noise generator maintains constant hiss level ..... p 66
By Daniel Cronin

Scope Analyzes Reciprocating Engines. Special cro is used as field maintenance tool to analyze ignition, vibration and pressure of reciprocating engines used in industrial and marine service ..... p 68
By Edward Sammis

Saturable Reactors Fire Radar Magnetrons. Magnetic modulator uses saturable reactors to convert input sine wave into narrow, high peak-power output pulses ..... p 72
By H. E. Thomas

High-Speed Tester Checks Tubes in Groups. Tube checker uses neon lamps to detect shorts and opens, with a memory circuit to show up intermittents ..... p 76
By E. S. Gordon

DIGEST CONTINUED ON NEXT PAGE

DIGEST continued

Transistor Q Multiplier for Audio Frequencies. High-Q, selectivity and stability are combined in simple, economical transistorized version of vacuum tube Q multiplier.....p 79
By G. B. Miller

Plug-in Bridge Checks VHF Quartz Crystals. Equivalent parameters of overtone crystals can be determined more rapidly and with less external equipment through use of unique bridge circuit for crystal under test.....p 82
By Douglas W. Robertson

Phase-Shift Curves. Relationship of phase-shift, frequency and gain are shown on curves for lead-lag networks so component values can be determined.....p 86
By Richard H. Engelmann

Transistor H-F Cutoff Nomograph. Conversion from one high-frequency transistor parameter to another is simplified.....p 88
By H. E. Schauwecker

Electrons At Work.....p 90

CRT Images Persist for Days..p 90
System Finds Electrode Reasonances.....p 90
By R. B. Tatge
Small Scale Countermeasure.....p 90
Feedback Stabilizes Flip-Flop....p 92
By Philip Checilik
Phase Shifter Range Exceeds 180°.p 96
By W. G. Shepard

Component Design.....p 102

Improved TV Picture & Set Styling.....p 102
Transformer Epoxy Conducts Heat.....p 102
High-Speed Computer Diode...p 102
Better Engineering Symposium..p 104
Smallest Molded Mica Capacitor.p 106
Eyelets for Printed Circuits.....p 108

Production Techniques.....p 110

Merry-Go-Round Ups Tube Output.....p 110
Instruments Boxed on Foam Base.p 110
Plates Connect Ribbon Cable...p 113
Peephole Packing Case.....p 115
Acid Sharpens Files.....p 115

New Products.....p 116

Literature of the Week.....p 148

Plants and People.....p 152

News of Reps.....p 157

New Books.....p 158

Comment.....p 162

Index to Advertisers.....p 175

electronics

May 9, 1958 Vol. 31, No. 19

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- Wide frequency range
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- Small size
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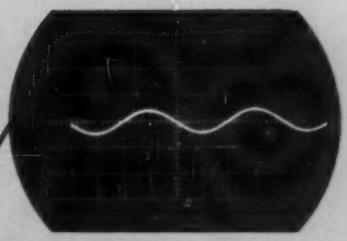
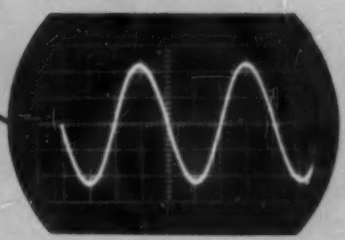
- Output constant with frequency
- High output
- Precision frequency control
- Compact and rugged
- Inexpensive

3 in 1

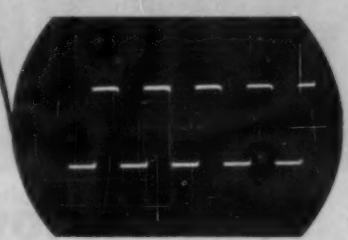
Type 1210-C Unit R-C Oscillator, $180.00



Low-Impedance (50 Ω) Output for Loads of 500 Ohms and Higher: No-load output is 0-7 v, constant to within ±1 db up to 200 kc; no-load distortion less than 1% from 200 c to 10 kc, less than 1.5% over entire frequency range; hum at least 60 db below output-voltage level.



High-Impedance (12.5 KΩ) Output for Loads of 10 Kilohms and Higher: No-load output is 0-45 v, constant to within ±1 db from 200 c to 150 kc; no-load distortion less than 5% from 200 c to 200 kc (distortion reduced under load); hum at least 50 db below maximum output level.



Square-Wave (2,500 Ω) Output: 0-30v peak to peak; rise time approximately ½ μ sec; overshoot approximately 1%; hum at least 60 db below output-voltage level.

The NEW General Radio 1210-C Unit Oscillator is the only oscillator in its price range to offer three separate output systems. Square waves and high- or low-impedance sine waves are yours at a turn of a knob.

This oscillator is unmatched in its class for all-around versatility. In addition to its usefulness as a source of sine and square waves for work at audio, ultrasonic, and low radio frequencies, the 1210-C can be employed as a modulator for r-f oscillators, and as a trigger for pulse generators.

Specifically designed for this instrument are two accessory Synchronous-Dial Drives that readily attach to the oscillator frequency control, allowing automatic plotting and display of amplitude frequency characteristics. Laborious point-by-point measurements are eliminated by this inexpensive sweep-driven oscillator system used with conventional recording equipment.

Frequency Range: 20-500,000 cycles in 5 ranges.

Frequency Controls: Range selection switch and 4-inch precision gear-driven dial. Dial has two scales, 2-20 and 50-500, and is geared to a slow-motion knob that covers each decade in about 4½ turns.

Frequency Accuracy: ±3%.

Output Control: Logarithmic, calibrated 0-50 db.

Power Requirements: 6.3 v a c or d c at 1 amp; 300 v dc at 50 ma; Type 1203-B Unit Power Supply ($40.) recommended for operation from 115 v, 50-60 cycles.

Fastening Power Supply: The Type 1210-C Oscillator can be firmly and permanently attached to any G-R Unit Power Supply by using the two stainless-steel locking strips supplied with oscillator.

ACCESSORIES

Type 908-P1 Synchronous Dial Drive, sweeps through one frequency decade in 50 sec; 908-P2 takes 6⅔ sec per decade, $29.00 for either.

Type 480-P4U3 Relay-rack Panel for mounting both 1210-C Oscillator and 1203-B Power Supply in one panel, $10.85

Type 1210-P1 Detector and Discriminator provides necessary voltages for convenient oscillograph display, $80.00

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Mass., U. S. A.

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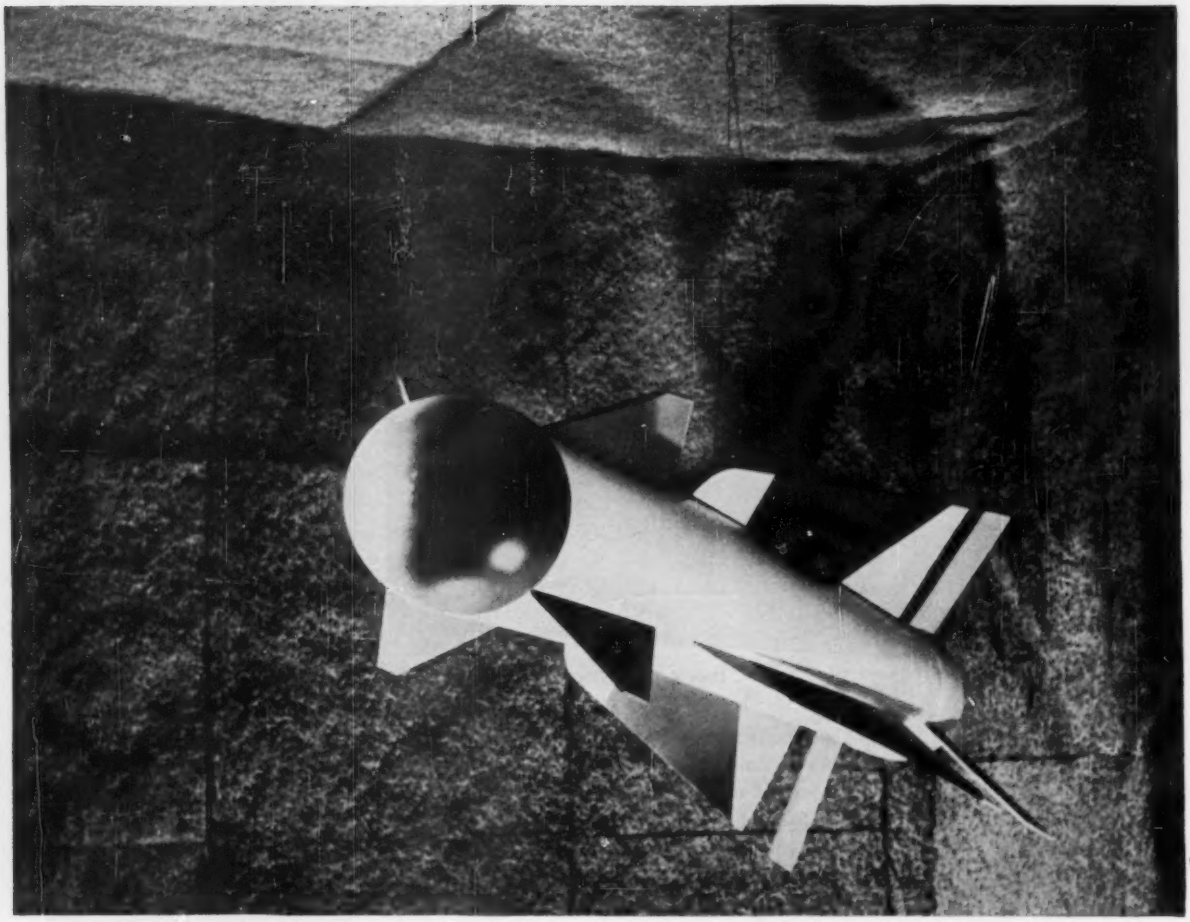


New low reflective absorbents makes free space tests more reliable

Ten times *lower* reflection is now available with all B. F. Goodrich Microwave Absorbents. This 0.1% material gives reliability to measurements previously unattainable for testing of guided missiles in a free space chamber.

You can now be sure, by selecting the proper B. F. Goodrich material, that you will get this 0.1% performance at any point on the microwave frequency spectrum.

In addition to this outstanding quality, the B. F. Goodrich absorbent is light-weight, fire-retardant, easy to install. It will not deteriorate in performance when walked upon and has excellent water and weather resistant properties. For darkroom use, a special white compound can be applied to the surface of the pads to increase light reflectance.

When you're investing thousands, start right—specify B. F. Goodrich—the company with the longest experience and record for *consistently* high quality microwave material. For new booklet on these absorbents write The B. F. Goodrich Company, 486 Derby Place, Shelton, Connecticut.

List of B. F. Goodrich Broadband Absorbents

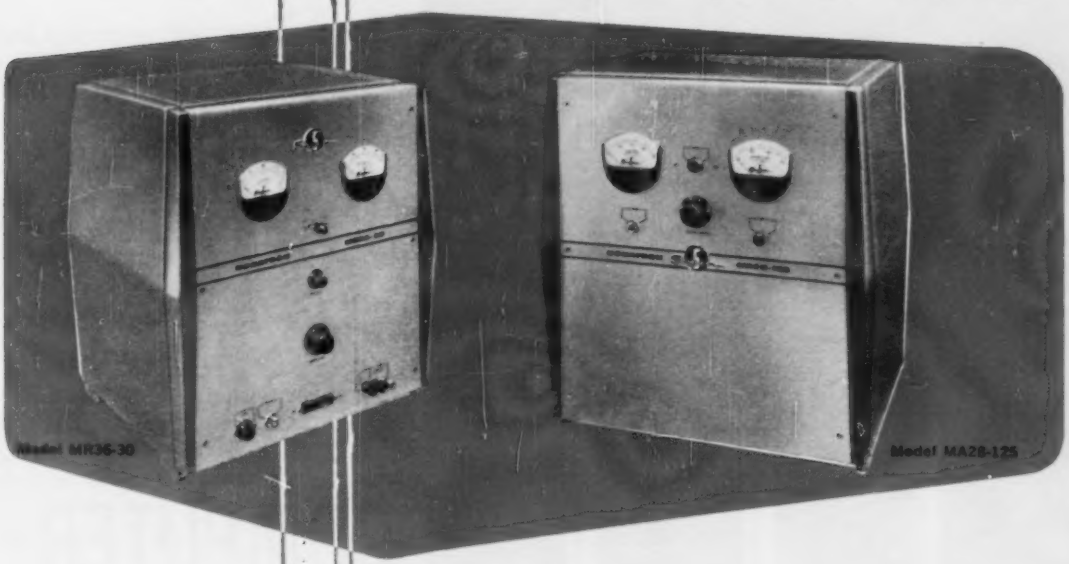
Designation	Lowest Frequency*	Thickness	Maximum Reflection
12 CM	2500 mc	1½"-2"	2%
12 CM – 1%	2500 mc	1½"-2"	1%
12 CM – 30db	2500 mc	1½"-2"	0.1% at X-band. 2% elsewhere.
6 CM	5000 mc	1"	2%
30 CM	1000 mc	3½"-4"	2%
30 CM – 1%	1000 mc	3½"-4"	1%
60 CM	500 mc	7"-8"	2%
60 CM – 1%	500 mc	7"-8"	1%
100 CM	300 mc	10"-11"	2%
200 CM	150 mc	26"	2%
600 CM	50 mc	69"	2%
8 CM–glass fiber	3600 mc	1"-1½"	2%
4 CM–glass fiber	7500 mc	¾"	2%

Most of the above absorbents can be furnished with 0.1% maximum reflection at selected points in the frequency band.

*All perform up to 30,000 mc

B.F.Goodrich
microwave absorbents

new High Current DC Supplies



Fast Response...High Amps...External Sensing

Model MA28-125
Output: 28 VDC nominal at 125 amps.
Regulation accuracy of ± 0.2%.
Ripple: < 1% RMS.
Response time: < 0.1 second.
Choice of input voltage: 208, 230, or 460 VAC, 3-phase.
Weight: 225 pounds.
$1160 in cabinet.

Model MR36-30
Output current, 0-30 amps, output voltage, 5 to 36 VDC continuously adjustable with regulation ± 0.25% against line or load change.
Response time of 0.2 second.
Input voltage: 105 to 125 VAC, single-phase.
Weight: 175 pounds.
$890 in cabinet.

Also supplied, as Model MR36-15, with output current 0-15 amps, otherwise similar.
Weight: 100 pounds.
$495 in cabinet.

Two new high output power-packs—with response time ranging from 0.2 second down, and with transistorized power reference and magnetic amplifier power control circuits for trouble-free performance—that's just part of the story on these Sorensen DC power supplies.

One model supplies an output of *18 to 36 VDC at 125 amperes;* the other provides 5 to 36 VDC at 0 to 30 amps. Zener diode reference circuit assures sharper regulation, and the external sensing provision puts this precise control at the load. Silicon power rectifiers and complete tubeless design increase durability with reduction in weight—and greater saving in size.

Get the full story from your Sorensen representative. Or write for technical data.

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New RAYTHEON RELIABLE COMPUTER TRANSISTORS switch 1 ampere

H_{FE} controlled at high currents

Temperature range −65°c to +85°c

Type	Punch through Voltage min.	f_{ab} ave. Mc	H_{FE_1} ave. $I_B = 1$ mA $V_{CE} = -0.25$v	H_{FE_2} ave. $I_B = 10$ mA $V_{CE} = -0.35$v	I_{CO} at −12v μA	r_b' $I_C = -1$mA ohms	C_{ob} $V_{CB} = -6$v μμf
2N658	−24	5	50	40	2.5	60	12
2N659	−20	10	70	55	2.5	65	12
2N660	−16	15	90	65	2.5	70	12
2N661	−12	20	120	75	2.5	75	12
2N662	−16	8	25 min.	50	2.5	65	12

Typical values at 25°C unless otherwise indicated

Dissipation Coefficients: In air 0.35°C/mW; Infinite Sink 0.18°C/mW

These new PNP Germanium Computer Transistors made by Raytheon's reliable *fusion-alloy* process add to the already comprehensive line of Raytheon Reliable Computer Transistors which include several in the *Submin* (0.160″ high, 0.130″ dia.) package. Write for Data Sheets.

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ELECTRONICS NEWSLETTER

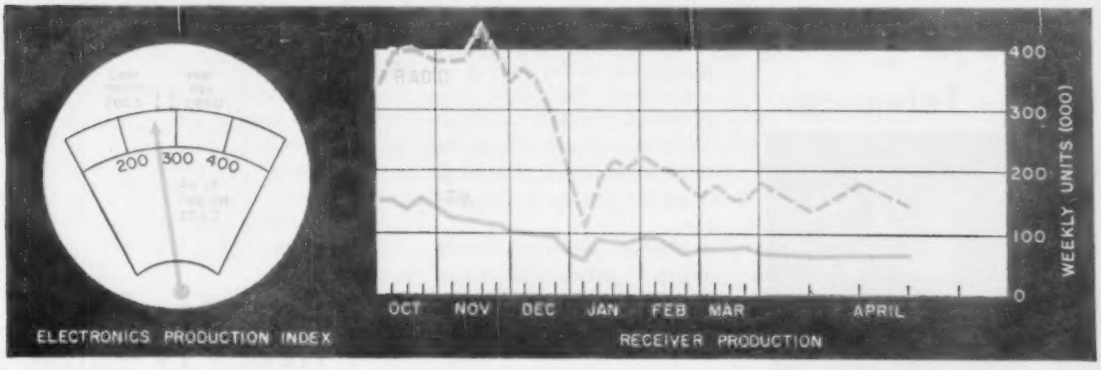
RUSSIA'S THIRD SPUTNIK, not yet launched at press time, reportedly weighs 5 to 6 tons. Its orbit around the earth may take it to the dark side of the moon. This was recently reported from Moscow by a Polish correspondent. He said the new Soviet sputnik will be put into orbit by a rocket much bigger and more powerful than those used in launching the first two. Its speed, he reported, will be great enough to put it in an orbit so far away that it will circle both earth and moon.

NATIONAL AERONAUTICS AND SPACE AGENCY recommended by President Eisenhower should have a three-part, comprehensive program, in the opinion of Hugh L. Dryden, director of the National Advisory Committee for Aeronautics. These would be: (1) an adequate research effort on space technology problems; (2) development and use of unmanned vehicles capable of carrying necessary scientific data-gathering apparatus; (3) development and orderly use of man-carrying vehicles in the exploration of the solar system.

RELIABILITY must be engineered into weapons systems projects from the outset, Air Force Gen. C. S. Irvine told the 1958 Electronic Components Conference in Los Angeles last month. He declared that (1) advanced findings of electronics research should be applied as quickly as possible and early test results fully and carefully analyzed; (2) materials engineering should assure that metals, alloys, ceramics and plastics will withstand environmental stresses; (3) mechanical engineering must not be a weak link in the chain. Irvine cited the need for automatic testing tools, checking equipment and more efficient instrumentation generally. In the case of the Atlas program, he said that only 30 percent of its cost went for missiles, with 70 percent for support gear. Firms that produce reliable, reasonably priced components should get a fair share of the $7 billion annual Air Force outlay for hardware.

SOVIET SINGLE-STAGE ROCKET which rose to 294-mi height Feb. 21 (ELECTRONICS, May 2, p 19), carried a barium titanate transducer to study micrometeor density. The Russians report that micrometeor movement was reliably determined up to 186 mi, with 268 collisions registered between 78 and 186 mi.

NEW MATERIAL FOR HIGH TEMPERATURE operation "could play a major role in the solution of severe reentry problems." That's what engineers John H. Lux of Haveg Industries and Norbert H. Noland of Reinhold Engineering and Plastics told last month's Canada-United States Chemical Engineering Conference in Montreal. Nose cones are already being made of the new material, described as a new class of compounds neither metal, plastic nor ceramic.



FIGURES OF THE WEEK

RECEIVER PRODUCTION

(Source: EIA)	Apr. 18, '58	Apr. 11, '58	Apr. 19, '57
Television sets, total	76,118	76,954	78,269
Radio sets, total	156,588	183,461	266,707
Auto sets	42,605	61,024	94,406

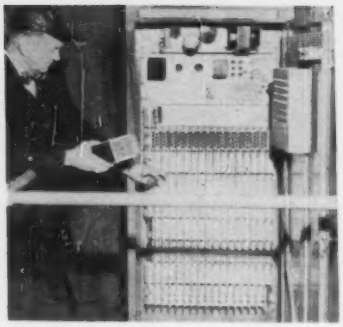
STOCK PRICE AVERAGES

(Source: Standard & Poor's)	Apr. 23, '58	Apr. 16, '58	Apr. 24, '57
Radio-tv & electronics	45.49	44.76	51.27
Radio broadcasters	58.73	58.31	68.74

FIGURES OF THE YEAR

Totals for first two months

	1958	1957	Percent Change
Receiving tube sales	56,466,000	82,031,000	−31.2
Transistor production	6,061,955	3,221,000	+88.2
Cathode-ray tube sales	1,178,046	1,489,223	− 2.1
Television set production	804,396	914,887	−12.1
Radio set production	1,903,418	2,350,294	−19.0
Tv set sales	1,030,213	1,148,796	−10.3
Radio set sales (excl. auto)	954,705	1,088,392	−12.3



Electronic memory unit (left) activates paddle system (right) to unload conveyor belt as railroaders . . .

Use Electronics To Sort

New transistorized system employing digital techniques solves costliest mail problem

TRANSISTORIZED SYSTEM using digital techniques for sorting parcel-post mail has been installed at Pennsylvania Railroad's Philadelphia terminal.

Railroaders say the new system, installed by Stewart-Warner, solves the costliest, most time-consuming problem of railway mail handling.

Problem: To sort parcels too large for mail sacks, and route them to the proper train.

Solution: Unsorted packages, ranging in size from egg crates to hand luggage, are placed on a 220-ft conveyor belt. As each item passes a coding station, two operators signal memory system to indicate at what point each parcel should be unloaded. System contains 39 removal points.

Code information is entered into a buffer storage unit as binary coded bits. An electric eye beamed across the conveyor belt senses passage of the parcel and transfers its coded unloading destination to a transistorized shift register.

As the parcel moves along the belt, coded information moves along the shift register. A decoder which is a large "AND" gate synchronized with the travel rate of the conveyor belt awaits the proper timing pulse.

When this occurs, a transfer mechanism in the form of a paddle is activated. The paddle pushes the parcel off the belt on to a right-angle conveyor. Waiting baggage trucks then pick up the parcels and move them to the proper train platform.

Manual sorting generally requires 15 men. This system does the job with five.

Previous practice allowed about 25 truckloads of mail to pile up before sorting. Crews worked at other tasks, rather than stop each time a truck arrived.

The new process allows sorting to complete itself once the main conveyor belt is loaded. Pennsy officials say arriving mail now makes the first train out.

It is reported several system proposals are being studied by other railroads, warehouses, and mail order companies. It is expected the system will be used on sacked mail now processed manually.

Installations may appear in New York, Chicago and Washington. System is also under consideration in Los Angeles, Boston, and some large midwest cities.

Polaris Telemeter

First photo of Polaris hardware shows Polaris test missile's telemetering unit getting check out before being sent to Lockheed's test facility at Cape Canaveral for firing

Transistor Output Up, Prices Down

TRANSISTOR'S TENTH ANNIVERSARY next month prompts a look at its growing market and dropping price levels. The trend to increased output and lower unit production cost continues this year.

Some 13 million units valued at $37 million were sold in 1956. By 1957 sales of more than 28 million units were worth $70 million. This year, as volume continues to rise, a number of price reductions have been announced.

At least two companies have recently cut prices ranging up to 25 percent on entertainment type germanium transistors. One says reductions are the result of increased output and new economies in production on some germanium types. The firm believes price cuts will spur use of germanium transistors for home entertainment sets.

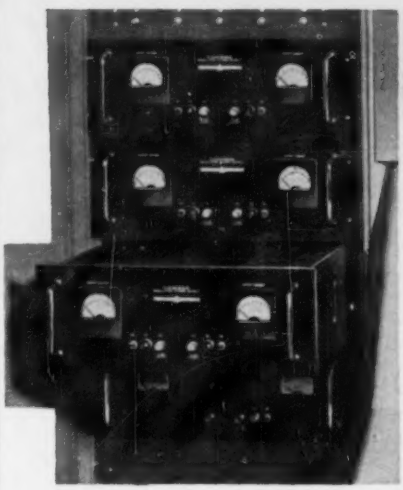
Another firm cut prices about eight percent on seven *pnp* alloy-junction types used primarily for audio-frequency amplifier, intermediate-frequency amplifier, broadcast-band converter and push-pull amplifier service.

Conservative estimate of ELECTRONICS researchers for 1965 is a market for 400 million transistors worth $200 million.

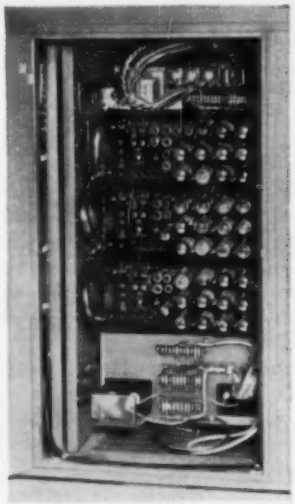
Satellite's Eye Needs Tv Retina

ASTRONOMERS at the Princeton University Observatory told ELECTRONICS in a recent interview that telescopic observation of the heavens from a satellite will require extensive tv camera tube research. The problem, they say, is that light gathered from faint astral

Digital Computer Intervention and Display System designed and fabricated by Stromberg-Carlson Company, a Division of General Dynamics Corporation, for the Air Proving Ground Center (ARDC) Armament Division, Eglin Air Force Base. The system is built around the CHARACTRON* Shaped Beam Tube, designed by Stromberg-Carlson for high-speed information display and micro-film recording.



C-800 Lambda Com-Pak Power Supplies used in the Eglin Air Force Base installation require only 7" front panel height.



Easy servicing. All wiring, tubes and other components are readily accessible. You can reach them easily, service them fast.

COM-PAK® SUPPLIES SAVE PANEL SPACE

Models through 1.5 amperes
Three voltage ranges: 0-200, 125-325, 325-525 VDC

C-200	series—	200 MA—5¼" panel height—from	$159.50
C-400	series—	400 MA—5¼" panel height—from	244.50
C-800	series—	800 MA—7" panel height—from	315.00
C-1500	series—	1500 MA—8¾" panel height—from	550.00

Where power supply dependability is vital

Stromberg-Carlson specifies standard Lambda power supplies for Air Force Digital Computer Intervention & Display System

Standard Lambda power supplies are components of the Digital Computer Intervention and Display System associated with the UNIVAC Scientific Computer at the Air Proving Ground Center (ARDC) Armament Division, Eglin Air Force Base, Florida.

Available for immediate delivery, Lambda power supplies from stock are being used in major rocket and missile programs, among other military projects. They are specified also for more industrial and research applications than the ten next-most-popular makes combined.

Send for the current Lambda catalog. It covers the complete new Com-Pak series, as well as other rack, bench and portable models, for all needs through 1.5 amperes.

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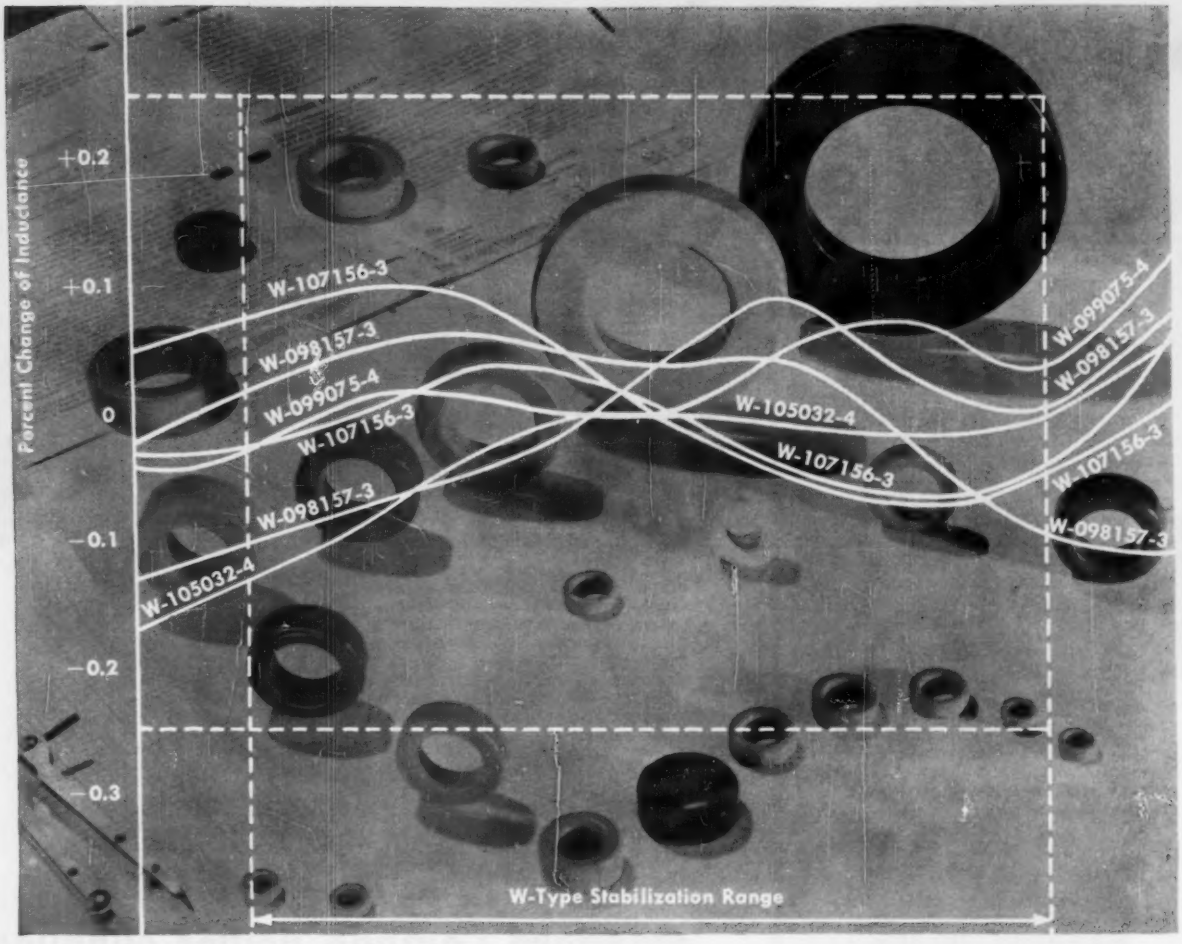
CIRCLE 5 READERS SERVICE CARD



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Arnold Molybdenum Permalloy powder cores are available with the temperature coefficient of inductance controlled within certain limits over specific temperature ranges. Most core sizes and permeability combinations can be supplied in at least one of the four different types of temperature stabilization available.

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WSW 6959

For more information write for Bulletin PC-104B

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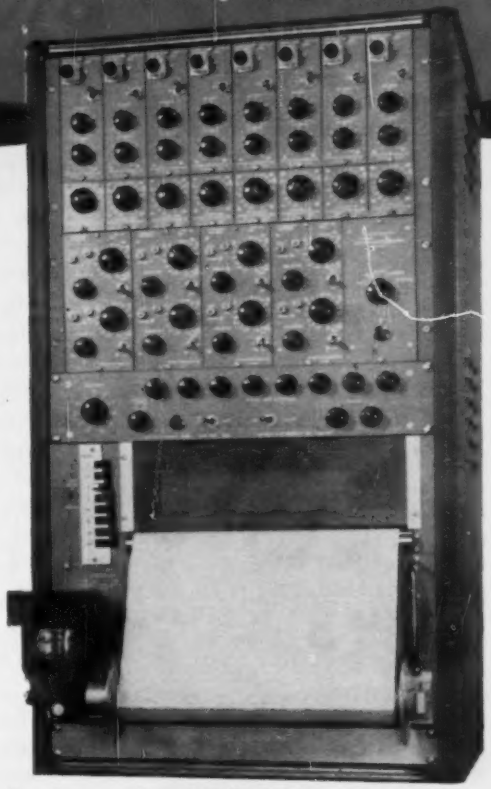

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bodies cannot be detected using available tubes. What is needed is an image-orthicon tube with a high-gain semiconductor target that can build up a charge over a period of an hour and a half before scanning without appreciable leakage from globule to globule in the mosaic, the astronomers say. If such a tube can be developed, it is planned to use tv techniques to aim the telescope, focus the image received, and photograph the image from a ground installation.

In the Navy's Stratoscope project (ELECTRONICS, Jan. 10, p 24) also under direction of Princeton University Observatory, the entire servo system, used to compensate for telescope motion and relative movement of the sun, and the camera are contained in a balloon gondola. Since space and weight are at a premium in a satellite, however, it is more feasible to use a telescope in conjunction with a tv camera and transmit the field of view to ground observers.

Telescope positional errors will be detected on tv monitors and corrected from the ground. Instead of using a satellite-borne camera whose film might be affected by spurious radiations, the monitor screen will be photographed. According to plans, the mosaic in the tv camera will be read at a rate of one scan per sec. This will permit use of conventional telemetering channels for data transmission.

Wide variey of transducers feed signals to this control board, making the . . .

A-Plant Control Bill $1.9 Million

INSTRUMENTATION and controls for the new full-scale civilian power reactor at Shippingport, Pa., cost $1.9 million, according to Westinghouse Electric Corp.

The instrumentation has four main jobs: providing information

WASHINGTON OUTLOOK

MANY MILITARY aircraft electronics contractors are complaining about Pentagon fiscal restrictions. There's talk about stretchouts in delivery schedules, requests for delayed billings, postponed contract awards and payment delays.

Defense Dept. spokesmen deny that slow payment measures are in the works. They dismiss the charges as a campaign to force the Pentagon to boost progress payments back to last year's 100 percent rate on cost-reimbursement type contracts. Current rate is 80 percent.

The Navy's Bureau of Aeronautics, however, is having serious fiscal problems. The agency is up against a tight budget ceiling, is trying to slash cash outlays between now and June 30. It has put into effect a new policy holding back contract awards unless the contractor agrees to forego progress payments at least until July 1.

- **The Air Force** denies talk of slow payments to contractors. "We are paying on time," says Asst. Air Force Secy. Lyle Garlock (Comptroller). "In fact, we're probably paying too promptly. In many instances we're paying the same day bills are tendered."

  Nevertheless, there seems little doubt that the Pentagon has been forcing some aircraft electronics contractors to carry a heavy financial load ever since last year's budget-cutting drive. And despite the speedup in defense production scheduling and contracting, there's no sign that the Defense Dept. will relax the restrictions on progress payments.

- **No one denies** that Defense Secy. McElroy has set up expenditure targets for the military services. In effect, these are ceilings on spending; but Pentagon budgeteers stress their flexibility. The sum for fiscal 1958, ending June 30, is now $39.1 billion—increased for the fourth time from the initial $38-billion estimate.

  Fiscal 1958 expenditures through March totaled $28.8 billion, which leaves $10.3 billion as the spending target for April-June. The $10.3-billion figure is slightly more than April-June 1957 spending.

  The target for fiscal 1959, starting July 1, is now $40.4 billion. This includes $7 billion for aircraft, $3.4 billion for missiles and $904 million for communications and other electronics. The target, however, is almost certain to be raised again.

- **The Air Force's Garlock** has sounded a warning to contractors. He has asked companies to project long-range billing plans based on existing development and production projects. If projected expenditures forecasts are "out of line," the Air Force "would have to change" production schedules, he says. So far, this hasn't been done.

- **Navy officials** are touting the virtues of a new management control system. They give it part of the credit for the fact that the Polaris missile-and-submarine weapons system is two years ahead of schedule.

  Electronics contractors are among those in industry that are studying the management control system for their own use, Navy men say. Similarly, other military services and the Pentagon's new Advanced Research Projects Agency are seeing whether they can use the system to keep control of their own research and development projects.

4357

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- *High Reliability*
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Display...Four (4) digit with automatic polarity indication and decimal placement. Total display area 2" high x 7.5" long, internally illuminated. Individual digits 1.25" high.

Automatic Ranges...0.0001 to 999.9 volts covered in four ranges.

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Counting Rate...30 counts per second, providing average balance (reading) time of 1 second, maximum balance time of less than 2 seconds.

Reference Voltage...Chopper-stabilized supply, referenced to an unsaturated mercury-cadmium standard cell.

Input Impedance...10 megohms, all ranges.

Output...Visual display, plus print control. Automatic print impulse when meter assumes balance. No accessories required to drive parallel input printers.

Input...115 volt, 60 cycle, single phase, approximately 75VA.

Dimensions...Control unit, 5¼" high x 19" wide x 16" deep. Readout display, 3½" high x 19" wide x 9" deep.

Weight...Approximately 40 lb.

Price...$2,100

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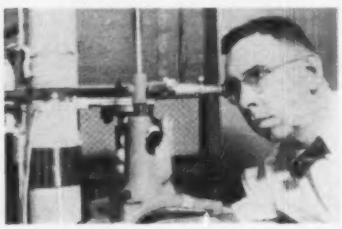
to the operators, running the safety circuits, providing reactor design information and protecting people in and around the plant from radiation hazards.

The nuclear reactor itself has two instrumentation systems. One monitors the core's neutron flux level with three independent channels, each provided with a proportional counter and a compensated ion chamber. These channels provide control data.

The other reactor system provides information on core conditions: temperature data from thermocouples, flow and differential pressure data, location of failed fuel elements and presence of fission products in the coolant.

A second group of instruments covers all the "conventional" measurements of the water system. Shippingport is a pressurized water reactor. Signals for control and alarm circuits are also supplied by thermocouples, thermometers and pressure instruments.



Molten zone of a gallium arsenide rod is examined at Bell Labs during crystal growing

Labs Pushing Intermetallics

INTERMETALLIC COMPOUNDS this year are showing new research promise for specialized device development. Indium antimony and gallium arsenide are among the compounds that may eventually find more widespread use in certain specific diode and transistor applications, ELECTRONICS learns.

One recent research success, floating zone refining of intermetallics, was announced last month by Bell Telephone Laboratories. Basic work was done on gallium arsenide, but scientists believe the method should be applicable to a variety of componds that are thermally unstable at their melting points.

In the technique, a heat source such as an r-f induction coil is moved relative to a vertically supported rod, melting a liquid zone as it moves. Surface tension supports the liquid zone. Usually, says Bell, a single crystal can be grown and purification achieved during this zone refining process.

Complicating factor in intermetallic crystal growing and purification is that composition of the liquid phase at the melting point is strongly dependent on the partial pressure of arsenic. In the zone-refining process, this is controlled by a sealed system containing excess arsenic and by regulating its minimum temperature.

Experimental crystals are com-

MILITARY ELECTRONICS

• **Why Atlas'** radio-inertial guidance system is virtually jam proof (ELECTRONICS, Apr. 25, p 14) has been further illuminated exclusively for ELECTRONICS.

Solution, according to a General Electric official, lies in the use of coded antijam filters which reject interference.

R. L. Shetler, manager of the company's Missile Guidance Section, said the highly-selective filters of a space, time and frequency nature make enemy jamming exceedingly difficult since the antijam devices are unique for each ICBM.

He added that jamming is made even more difficult because radio signals controlling the Atlas guidance system are only transmitted during the first few minutes of the Atlas' flight, while the missile is over friendly territory.

• **Support equipment** for ballistic missiles and interceptor aircraft provides bigger business than do the actual weapons.

"Aproximately two-thirds of the money being spent on the IRBM and ICBM programs will be spent on the equipment required to handle, transport, test, check-out and repair the missiles.

"In air defense, an ever increasing proportion of the money is going into radar, communications and control systems as opposed to the actual interceptor weapons," Gen. Thomas D. White, Chief of Staff, USAF, told the American Ordnance Association in St. Louis recently.

Construction of two ICBM sites —one in the Offutt AFB, Omaha, area and one near Fairchild AFB, Washington—is scheduled to begin before Oct.

The cost of each is estimated at $25 million.

Technical design of the missile facilities will be under control of the AF Ballistic Missile Division, Inglewood, Calif. Other aspects of the design and all construction will be accomplished through the Army Corps of Engineers.

• **ARDC's Hyfinder** crash locator beacon, equipped with parachute, automatically ejects itself from a doomed plane before crash, sets itself up for operation on land or sea, transmits SOS and homing signals on vhf and h-f transmitters, and flashes a stroboscopic light 30 times a min that is visible for 25 mi. Produced by Hycon Manufacturing, the instrument package measures 3 ft by 8 in. and weighs 56 lbs. The telescoped antenna shoots up 12½ ft. A rubber raft inflates for landing in water and three heavy metal legs extend for ground operation.

• **SINS** (Ship's Inertial Navigation System) for the first two Polaris submarines will be designed and built by Autonetics div. of North American. Sperry, which has responsibility for its SINS for the *USS Compass Island* and *USS Observation Island*, will, according to a high-ranking Navy spokesman, furnish several sizable items in the Autonetics system.

Tonotron* picture of the Los Angeles Yacht Harbor

The Hughes TONOTRON tube presents a complete spectrum of grey shades. **Result:** high-fidelity picture reproduction. The illustration above, for example, is an unretouched photo of a typical radar display as viewed on the face of a TONOTRON E.I.A. Type 7033 Tube.

Additional outstanding characteristics of the TONOTRON tube are high brightness (in excess of 1500 foot lamberts with full half tone range) and controllable persistence. The family of TONOTRON tubes is ideally suited for ground mapping, weather radar displays, slow-scan TV, "B" scan radar, oscillography, armament control radar, optical projection systems, and miniature radar indicators.

Other Hughes cathode-ray storage tubes: The MEMOTRON® tube displays successive transient writings until intentionally erased. The TYPOTRON® tube, an exceptionally high-speed character writing tube, displays any combination of 63 letters or symbols until intentionally erased.

Creating a new world with ELECTRONICS

For complete technical data please write Hughes Products, Electron Tube Division, International Airport Station, Los Angeles 45, California

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parable in size to germanium or silicon crystals. Right now, purity level is somewhat below that of silicon, at about one part of impurity per million.

Technique should be most useful with binary compounds in which only one component element has a considerable vapor pressure at its melting point, scientists believe. They add that the compound must have a high enough electrical conductivity to permit heating by r-f induction. Furthermore, surface tension and density of the molten material must be able to support a molten zone during the refining process.

Sound Cleans Surgical Tools

DRIED BLOOD, bits of tissue and other soils on surgical instruments are removed by cavitation caused by ultrasonic sound waves (upper photo) generated in a new medical washing machine (lower photo) manufactured by Acoustica Associates, Inc., of Mineola, N. Y.

The washer will clean 75 instruments in only 13 min. By hand scrubbing, 45 min are necessary to clean the same number.

The 25-kc magnetostriction-generated ultrasonic signal unit differs from other ultrasonic units in that the output is pulsed; peak power is over 1,000 watts while average power is 400 watts.

FINANCIAL ROUNDUP

• **Reduction in interest rate** charged by commercial banks to prime borrowers from 4 to 3½ percent in last fortnight is of more than passing interest to electronics industry. Rate reduction should speed up tempo of banks' buying of electronic equipment (ELECTRONICS, May 2, p 15). Savings in operating costs possible through electronic automation will be more attractive than ever with future gross revenue headed for a drop under impact of lower interest rates. Actually only an exclusive circle of top credit risks quality to borrow money at prime bank interest rates. But the interest rates charged to other customers usually drop with the prime rate.

• **Technitrol Engineering,** of Philadelphia, and **L & O Research and Development,** Wayne, Pa., plan to merge sometime this year. Technitrol and L & O will exchange common shares. Further financial details were not disclosed. A. F. Carey, L & O president, has become vice-president of Technitrol, the acquiring company which makes data processing equipment and components. The to-be-acquired firm is in the data recording and facsimile fields.

• **Ampex Corp.,** Redwood City, Calif., plans to split common stock 2½ to 1. Split, voted by board of directors, is subject to approval by shareholders in August. Stock was recently quoted at 57½ bid over-the-counter. There are 734,265 shares outstanding. Redwood firm manufactures magnetic tape recording equipment. It owns a 25 percent interest in **Orradio Industries** of Opelika, Ala., magnetic tape manufacturer.

• **Itek Corp.,** of Boston, and **Vectron Corp.,** Waltham, Mass., will submit merger plans for stockholder approval in next two weeks. Merged firms will operate under name of Itek Corp. and plan, within a year, to consolidate all activities in Vectron's Waltham plant. Itek does engineering research in graphic information processing. It recently acquired facilities and staff of **Boston University's Physical Research Labs.** Vectron manufactures electromechanical and electronic equipment.

• **I T & T** plans to issue $28.7 million of 25 year convertible subordinated debentures. Terms of proposed financing call for stockholders to be offered right to subscribe to debentures at rate of $100 principal amount for each 25 shares of capital stock. Interest rate, common stock conversion prices and subscription price will be determined shortly before the offering is made. Kuhn, Loeb & Co. of New York City will head the underwriting group.

Aircraft A-Power Program Widens

AEC EXPECTS to make first tests late this year of nuclear reactor systems being developed for rocket propulsion. Flight tests of atom-powered rockets would come after 1960.

Buildings to house the instruments associated with the field testing are now being constructed in atomic weapons test areas.

Unofficial sources predict the project will culminate in missiles able to circle the earth constantly, except for maintenance landings. The same sources say electronic guidance for such a weapons system is feasible.

The rocket program is part of the AEC's aircraft reactor propulsion program, which cost AEC $87 million in research and development in fiscal 1957.

National Advisory Committee for Aeronautics is building a reactor for its study of nuclear aircraft problems. Rated at 60,000 kilowatts, it will be one of the most powerful research reactors ever built.

The $250,000 control contract

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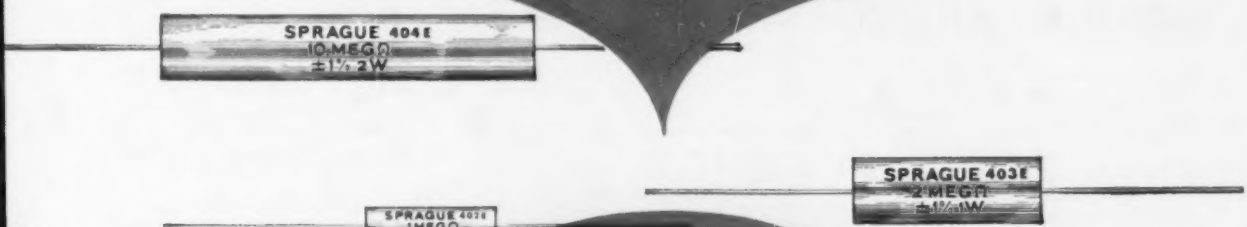

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has been awarded to Leeds & Northrup. Among the instruments NACA will get are a thermal computer to measure the reactor's heat output and a power limiting system made with both transistors and magnetic amplifiers.

Phototube Control Sets Printed Page

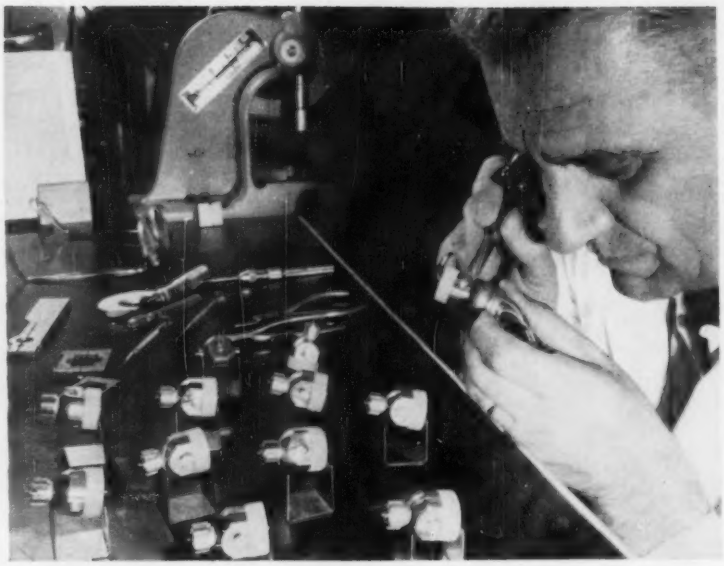
HIDING OUT in a print shop during World War II, two members of the French underground, with plenty of time to watch and observe printers and typesetters, came to the conclusion that something should be done about applying modern technology to the print shop.

And they set to work to update Gutenberg.

These men, Louis Moyroud and Rene Higonnet, eventually came to America and contacted Vannevar Bush. He sent them to MIT. From that point, they began to perfect an automatic typesetting machine.

A matrix disk contains the type fonts. Electronic gates fire the matrix for rough positioning, and a thyratron trigger from a phototube controls the type image, which is recorded on film. The automatic typesetter sells for $50,000 and may cut composing-room costs in half.

Shown in New York, this automatic typesetter and composer is manufactured by Photon, Inc., of Cambridge, Mass. The company already has a backlog of orders. The typist can set 16 fonts in twelve point sizes. Computers take care of complicated area composition, type justification and the vast numbers of hand operations formerly required to prepare type for the printed page.



Gnat Gyros for Small Missiles

Tiny gyros, used in guidance of Army Hawk and Navy Sparrow III missiles are in mass production at Raytheon. Each gyro gets 100 assembly and test operations

MEETINGS AHEAD

May 12-14: Instrumental Methods of Analysis, ISA Annual Symposium, Shamrock-Hilton Hotel, Houston, Texas.

May 12-14: National Aero & Nav. Elec. Conf., PGANE, Biltmore Hotel, Dayton, Ohio.

May 12-15: Eighth Annual Research Equip. Exhibit and Instrumentation Symposium, PGME-IRE National Institute of Health, Bethesda, Md.

May 13-15: Communications Section of the Assoc. of American Railroads, 34th Annual Meeting, Hotel Muehleback, Kansas City, Missouri.

May 13-15: Radio Tech. Comm. for Marine Services, Spring Assy, Ben Franklin Hotel, Philadelphia.

May 13-15: East Central District Meeting, AIEE, Pritchard Hotel, Huntington, West Virginia.

May 19-21: Electronic Parts Distributors Show, Conrad Hilton Hotel, Chicago.

May 19-23: International Convention on Microwave Valves, Institute of Electrical Engineers, contact secretary, Savoy Place, London.

May 21-23: Energy Instrumentation Conf., Automatic Controls Applied to Gas, Electric and Steam Systems, ISA, New York City.

May 27-28: Second EIA Conf. on Maintainability of Electronic Equip., Univ. of Penn., Phila.

June 2-4: National Telemetering Conference, AIEE, ISA, ARS, Lord Baltimore Hotel, Baltimore, Md.

June 2-4: Automation and Computers, Short Course and Conf., Univ. of Texas, College of Engineering, Austin, Texas.

June 4-6: Armed Forces Communications and Electronic Assoc., Exhibit, Hotel Sheraton Park, Washington, D. C.

June 5-6: Second Natl. Conf. on Production Techniques, IRE, PGPT, Hotel New Yorker, N. Y. C.

June 9-13: Technical Writers Institute, Sixth Annual Symposium, Rensselaer Polytechnic Institute, Troy, N. Y.

June 9-13: Automation Seminar, Fourth Annual, Penn. State Univ., Penn.

June 10-13: Sixth Annual Meeting, Human Engineering Institute, Stamford, Conn. Contact Roland C. Casperson.

June 16-18: Electrical Contact Seminar Div., Penn State Univ., Penn.

June 16-18: Military Electronics Second National Convention, Sheraton Park Hotel, Washington, D. C.

June 17-27: Two-week Special Summer Program in Switching Circuits, MIT, Cambridge, Mass.

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EIA TO-9
Outline Package

EIA TO-3
Outline Package

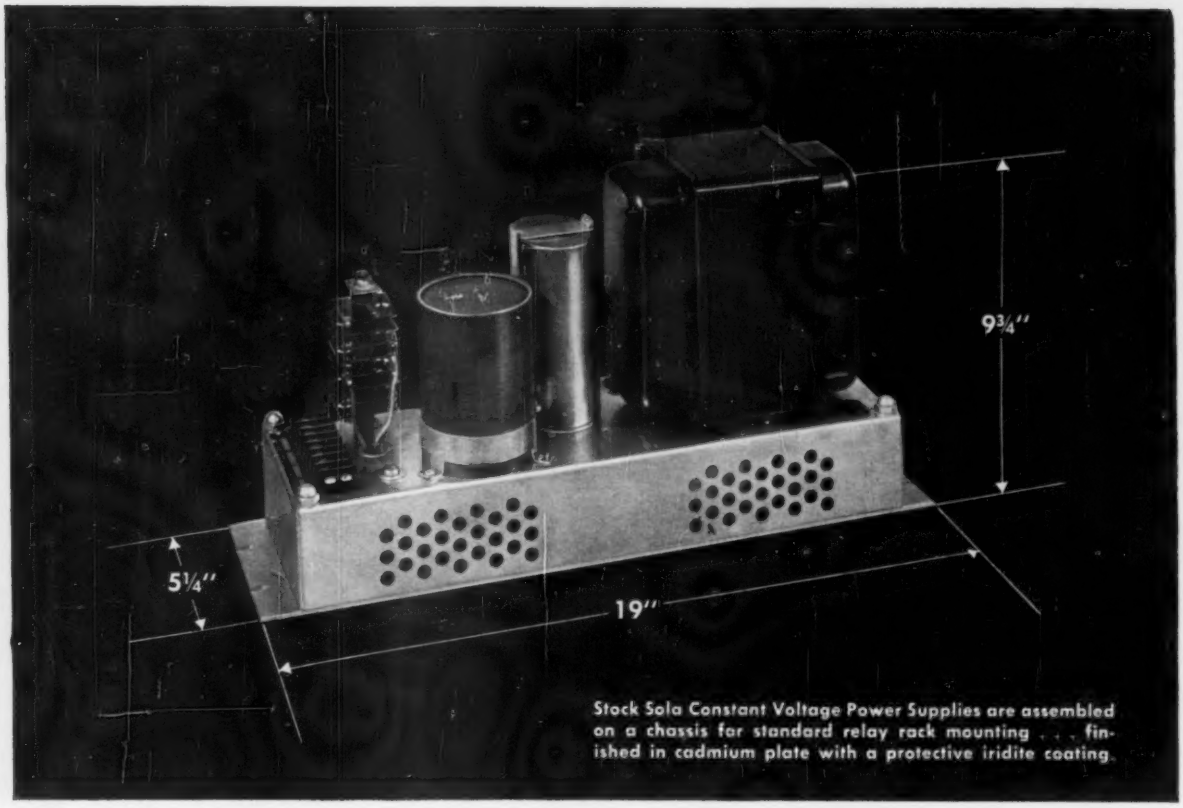
Tung-Sol types and ratings are listed below with the types they replace. From these, spot your needs! Then, for long-life operation, specify Tung-Sol!

TYPE	APPLICATION	MAXIMUM RATINGS (25° C) Pc mw	Vce volts	Vcb volts	Ic ma	Tj °C	TYPICAL VALUES (25° C) MAX. Icbo μa	Hfe	fab mc	Ge db	SIMILAR TYPE REFERENCE
MEDIUM POWER AUDIO TYPES (To-9 Outline)											
2N381	Output Amplifier	200	25	25	200	85	20	36	1.2	31	2N61, 2N186/A, 2N187/A, 2N266
2N382	Output Amplifier	200	25	25	200	85	20	54	1.5	33	2N60, 2N180, 2N181, 2N185, 2N188/A, 2N226, 2N311, 2N403, 2N408
2N383	Output Amplifier	200	25	25	200	85	20	72	1.8	35	2N59, 2N224, 2N241/A, 2N265, 2N270
2N460	General Purpose Industrial	200	—	45	400	100	15	25	1.5	39	2N44
2N461	General Purpose Industrial	200	—	45	400	100	15	50	1.5	41	2N43
HIGH FREQUENCY TYPES (To-9 Outline)											
2N404	Computer	100	24	30	400	85	5	30	12	—	2N581
2N425	Computer	100	20	30	400	85	5	30	4	—	2N394, 2N578
2N426	Computer	100	18	25	400	85	5	40	6	—	2N269, 2N395, 2N579
2N427	Computer	100	15	20	400	85	5	55	11	—	2N123, 2N315, 2N396, 2N580
2N428	Computer	100	12	15	400	85	5	80	17	—	2N316, 2N397, 2N582
2N413	RF Amplifier	100	15	—	200	85	5	—	3	—	2N111, 2N135, 2N410
2N414	RF Amplifier	100	15	—	200	85	5	—	5	—	2N139, 2N112, 2N136, 2N218, 2N412
2N416	RF Amplifier	100	15	—	200	85	5	—	10	—	2N113
2N417	RF Amplifier	100	15	—	200	85	5	—	20	—	2N114
HIGH POWER TYPES (To-3 Outline)		Pc w	Vce volts	Vcb volts	Ic Amps.	Tj °C	MAX. Icbo ma	Hfe	fab mc	Ge db	
2N242	Audio Amplifier	15	45	—	2	85	1.0	50	0.4	34	2N155, 2N176, 2N250, 2N257, 2N301/A, 2N350, 2N351, 2N554, 2N555
2N378	Power Switch	15	20	40	3	85	0.5	35	0.3	24	2N255
2N379	Power Switch	15	40	80	3	85	0.5	30	0.3	23	2N158/A, 2N251, 2N296, 2N297
2N380	Power Switch	15	30	60	3	85	0.5	60	0.4	29	2N156, 2N256, 2N387
2N459	Power Switch	15	60	105	3	85	0.5	40	0.3	24	2N375

NOTE: *Similar type references are listed at time of printing and should be interpreted as approximate equivalents. This reference does not necessarily imply exact electrical or mechanical interchangeability.*

To fill your special transistor requirements or for full facts on any of these standard Tung-Sol types, write or phone: *Semiconductor Division, Tung-Sol Electric Inc., Newark 4, New Jersey. Sales Offices: Atlanta, Ga., Columbus, Ohio, Culver City, Calif., Dallas, Tex., Denver, Colo., Detroit, Mich., Irvington, N. J., Melrose Park, Ill., Newark, N. J., Seattle, Wash.... Canada: Toronto, Ont.*

TUNG-SOL®



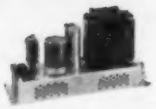
Stock Sola Constant Voltage Power Supplies are assembled on a chassis for standard relay rack mounting . . . finished in cadmium plate with a protective iridite coating.

COMPACT, regulated DC power supply

Looking for a source of regulated dc power that fits into a little space? If so, then you'll find the Sola Constant Voltage DC Power Supply is just what you want.

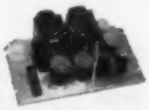
You'll also like to know that this space-saver is a top performer too. It's ideal for intermittent, variable or pulse loads. It delivers current in the "ampere range", regulates within ±1% with up to 10% line voltage variation, has less than 1% rms ripple, and even tolerates dead shorts. This dc power supply is 80% efficient and has an output impedance which is very low.

How's it done? Well, the answer is a unique combination of three components. A special Sola Constant Voltage Transformer is teamed up with a semiconductor rectifier and a high-capacitance filter. The Sola transformer's electrical characteristics maximize most of the advantages of the rectifier and filter, while virtually eliminating all their disadvantages. The resultant regulated dc power supply is simple, highly reliable, compact and moderately priced.



Fixed output — six ratings available from stock

Adjustable output — six ratings from stock



Custom-designed units produced to your specs

Write for Bulletin 7E-DC-235

Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill., Bishop 2-1414 • Offices in Principal cities • In Canada, Sola Electric (Canada) Ltd., 24 Canmotor Ave., Toronto 14, Ont.

INSTANT PRODUCTION TESTING of Coils, Capacitors, and Resistors!

SPECIFICATIONS

OSCILLATOR FREQUENCY RANGE: 200 Kc. to 70 Mc. in 11 ranges, using 6 plug-in inductors.

INDICATING SYSTEM: Large 5" cathode ray tube, calibrated in % Q on the vertical axis and % L-C on the horizontal axis.

TOLERANCE LIMITS: ±25% Q, calibrated in increments of 5%; ±5% and ±20% L-C, calibrated in increments of ±1% and ±5% respectively.

Q RANGE: 50 to 500

INDUCTANCE RANGE: 1 Microhenry to 10 Millihenries.

CAPACITANCE RANGE: 2 MMF. to 1000 MMF.

RESISTANCE RANGE: 1000 to 500,000 Ohms.

POWER SUPPLY: 105-125 Volts, 50-60 Cycles.

PRICE: $750.00 F.O.B. Boonton, N. J.

- **SAVES VALUABLE INSPECTION TIME**
  Gives you instantaneous readout
- **EXTREMELY SIMPLE TO USE**
  No operator training required
- **NO TUNING OR ADJUSTMENT NECESSARY**
  Gives simultaneous indication of both Q and L-C
- **ELIMINATES OPERATOR MEASUREMENT ERROR**
  Single readout on large CRT screen

Write for complete information

BOONTON RADIO CORPORATION
Boonton, New Jersey

TWO channels for ONE

with NORTHERN RADIO...

NEW! TWINPLEX COMMUNICATION UNITS

• provide 2 channels of FS communication with existing single channel transmitter and receiving facilities—with performance comparable to the existing single channel system

This Twinplex communication system makes possible a 2-channel radio circuit whereby 2 non-synchronous or synchronous telegraph transmissions modulate a single radio carrier wave by causing the carrier to assume one of four specific frequencies with 400 cps separations.

The transmitting equipment consists of the Twinplex Combiner Type 177 Model 1 and an RF Frequency Shift Keyer such as the Northern Radio Type 105 Model 4. The Combiner converts the four possible conditions of two telegraph signals (M1-M2, M1-S2, S1-M2, S1-S2) respectively into one of four voltages related in a 0-1-2-3 manner. The Combiner output voltage modulates the FS Keyer.

The receiving equipment consists of the Twinplex Converter Type 178 Model 1 and a single or diversity receiver such as the Northern Radio Type 110 Dual Diversity Receiving System. The Converter demodulates and separates the four audio tones from the radio receiver(s) into two channels each carrying the originally transmitted intelligence. The Twinplex Converter replaces the standard FS Converter for this purpose.

The two telegraph channels provide the same operational flexibility as that of two separate single channel FS systems. One can, for example, simultaneously use channel #1 on 60 wpm teletype and channel #2 on high-speed Morse or Time Division Multiplex. It further permits the reception of channel #1 signals on all standard FS converters (tunable to 400 cps shift) without need for a Twinplex Converter: this is valuable for "Forked Circuit Operation" where the intelligence of channel #1 is intended for pick-up by other receiving stations which are not equipped for Twinplex Reception in addition to the main receiving stations which are so equipped. Reception of channel #2 (or of both channels) requires the receiving end to be equipped with a Twinplex Converter.

Write for complete information.

- Frequency Shift Keyers
- Master Oscillators
- Diversity Receivers
- Frequency Shift Converters
- Multi-Channel Tone Systems
- Tone Keyers
- Demodulators
- Monitors
- Radio Multiplex Systems
- Tone Filters
- Line Amplifiers
- Twinplex Equipment

NORTHERN RADIO COMPANY, inc.

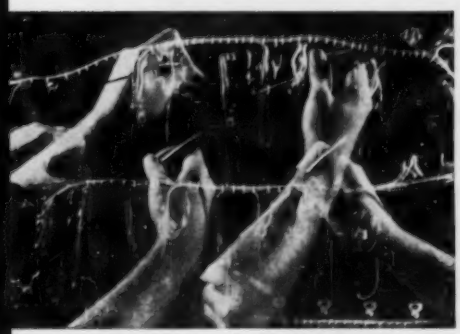
147 WEST 22nd ST., NEW YORK 11, NEW YORK

Pace-Setters in Quality Communication Equipment

IN CANADA: Northern Radio Mfg. Co., Ltd., 1950 Bank St., Billings Bridge, Ottawa, Ontario.

"BEST IRON WE'VE HAD in the plant," says William Fish, a production supervisor of General Radio, Cambridge, Mass. This company has switched to G-E Midget irons for soldering *both* delicate and heavy joints in their Type 1862-B Megohmmeters —jobs which formerly required *both* a heavy and a light iron. G-E Midget iron's light weight also helps reduce fatigue.

50 G-E Midget irons do work of 100 former irons at General Radio Co., boost production 25%



FASTER HEAT RECOVERY and lower maintenance of G-E soldering irons have been proved by many manufacturers under their own production conditions—along with competitive soldering irons. If you would like to compare General Electric irons with the irons you are now using, call your G-E distributor.

DELIVERY TODAY is now possible on popular soldering irons and other General Electric heaters and devices from a local distributor near your plant. Your replacement inventory may be reduced. For the name of your nearest stocking distributor for G-E heaters and devices, call your General Electric Apparatus Sales Office.

SAVINGS ACHIEVED by several users and information about the construction features of General Electric soldering irons are included in a new bulletin, "Save While You Solder," GED-3553. For a copy, call your G-E distributor or write Section 724-3, General Electric Company, Schenectady 5, New York.

GENERAL ELECTRIC

CIRCLE 15 READERS SERVICE CARD

Direct, automatic power readings

CW or pulsed power

Wide frequency range

No calculations

Assured accuracy

Operates with wide variety of bolometers

-hp- 430C
Microwave Power Meter

Here is the finest, most dependable source of instantaneous microwave power readings available today. The *-hp-* 430C gives you power readings direct in db or mw and completely eliminates tedious computations or troublesome adjustment during operation. The instrument measures either pulsed or CW power on either waveguide or coaxial systems. Operation is entirely automatic, stability is extremely high, and the meter may be used with a wide variety of bolometer mounts having either positive or negative temperature coefficients. The broad nominal measuring range can be extended to higher powers by means of directional couplers and attenuators.

For measurements of CW or pulsed power, *-hp-* 430C uses either an instrument fuse, barretter or thermistor as a bolometer element. Operation may be at either 100 or 200 ohms. Power is read direct in milliwatts from 0.02 to 10 mw, or in dbm from —20 to +10 dbm.

SPECIFICATIONS

Power Range: 5 ranges, front panel selector. Full scale readings of .1, .3, 1, 3 and 10 mw. Also continuous readings from —20 to +10 dbm. (0 dbm = .001 watt). Power range may be extended with attenuators or directional couplers in microwave system.

External Bolometer: Frequency range depends on bolometer mount. Bolometers can operate at resistance levels of 100 or 200 ohms and can have positive or negative temperature coefficients. Any dc bias current up to 16 ma is available for biasing positive or negative temperature coefficient bolometers. Dc bias current is continuously adjustable and independent of bolometer resistance and power level range.

Suitable bolometers are:

Instrument fuses: *-hp-* G-28A and G-28B 1/100 amp fuse.

Barretters: Sperry 821, Narda N821B or N610B, PRD 610A, 614, 617 or 631C.

Thermistors: Western Electric D166382, Victory Engineering Co. 32A3, 32A5, Narda 333, 334.

Accuracy: ±5% of full scale reading.

Power: 115/230 v ±10%, 50/1,000 cps, 75 watts.

Dimensions: Cabinet Mount: 7⅜" wide, 11½" high, 14" deep. Rack Mount. 19" wide, 7" high, 12½" deep.

Weight: Net 14 lbs. Shipping 32 lbs. (cabinet mount).

Price: $250.00.

Data subject to change without notice.

hp ELECTRONIC TEST INSTRUMENTS for

Use these precision -*hp*- instruments with -*hp*- 430C for greater coverage, convenience

-*hp*- 752 Multi-Hole Couplers—For measuring average power 1 watt to 1 kw (with attenuator) in waveguide systems. Models cover all frequencies 2.6 to 40 KMC. Coupling factors of 3, 10 and 20 db available most bands. Directivity better than 40 db full range; accuracy within ±.7 db full range. Primary guide SWR less than 1.10. $375.00 to $75.00.

-*hp*- 764-767D Dual Directional Couplers—For wide band coax reflectometer and power measurements. Four models cover frequencies 216 to 4000 MC. 20 db attenuation, coupling accuracy 0.5 db, max. primary SWR 1.1 to 1.25; max. secondary SWR 1.2 to 1.5. Minimum directivity (216 to 940 MC) 30 db; 26 db at higher frequencies. 50 watts CW capacity, 10 kw peak. Low insertion loss. $125.00 (any frequency).

-*hp*- 382A Precision Attenuators—For measurements up to 5, 10 and 15 watts, this revolutionary new broad band instrument may be employed. -*hp*- 382A attenuates from 0 to 50 db, full range, independent of frequency. Phase shift constant with attenuation. Accuracy within ±2% of db reading. Models cover frequencies 3.95 to 40.0 KMC, maximum dissipation 5 to 15 watts. SWR less than 1.15. $500.00 to $250.00.

-*hp*- 370 Waveguide Attenuators — Waveguide sections providing fixed amounts of attenuation. Used to extend power range of -*hp*- 430C. Models for frequencies 2.6 to 18.0 KMC, power dissipation 1.0 watts (1 kw peak), SWR 1.15; 3, 6, 10 or 20 db attenuation. $75.00 to $55.00.

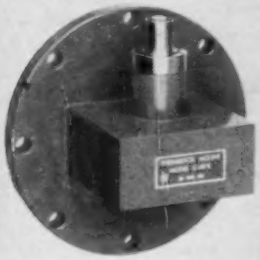
-*hp*- 487B Thermistor Mounts—Simplify setups, save time and insure maximum accuracy in waveguide power measurements. Models cover frequencies 3.95 to 26.5 KMC with full range SWR of less than 1.5 (except K487B, 2.5). Permanently installed negative temperature coefficient thermistors. No tuning, large overload factor makes burnout virtually impossible. $95.00 to $75.00.

-*hp*- 485 Detector Mounts

-*hp*- 382A Precision Attenuators

-*hp*- 476A Bolometer Mount

-*hp*- 752 Multi-Hole Couplers



-*hp*- 487B Thermistor Mounts

-*hp*- 477B Coaxial Mount

-*hp*- 477B Coaxial Mount — Thermistor mount providing full frequency coverage 10 MC to 10 KMC with SWR less than 1.5. Requires no tuning, uses long time constant elements for accuracy even on low duty cycle pulses. For use with 430C or other bolometer bridges providing negative temperature coefficient operation at 200 ohms. Requires 13 ma bias. Power range 0.02 to 10 mw. Uses Type N rf connector. $75.00.

-*hp*- 485 Detector Mounts — Single tuning control accurately matches waveguide section to bolometer element; instrument also detects rf energy with crystal substituted for bolometer element. Models for frequencies 2.6 to 18.0 KMC, SWR 1.25 to 1.5. All models employ crystal or barretter except P485 (thermistor only) and S485 (crystal only). $125.00 to $75.00.

-*hp*- 476A Bolometer Mount—Universal bolometer mount requiring no tuning, no adjustment. Frequencies 10 to 1,000 MC, instantaneous, automatic power readings 0.02 to 10 mw. SWR less than 1.15, 20 to 500 MC; less than 1.25, 10 to 1,000 MC. Uses four 1/100 amp fuses. Uses Type N rf connectors. $85.00.

-*hp*- 764/7D Dual Directional Couplers

Prices f.o.b. factory. Data subject to change without notice.

HEWLETT-PACKARD COMPANY

4651A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U. S. A.

Cable "HEWPACK" • DAvenport 5-4451

FIELD REPRESENTATIVES IN ALL PRINCIPAL AREAS

COMPLETE COVERAGE, HIGHEST QUALITY

Cat. No. 867-A

NEW KAY *Vari-Sweep*

MODEL 400

Wider Range, All-Electronic Sweeping Oscillator, or *(with sweep off)* Continuously Tuned CW Signal Source

HIGH Output—1.0 V rms into 70 ohms

WIDE Range—15-470 mc all at Fundamental Frequency

CONSTANT Output—fast-acting AGC circuit

- **New Wider Range—15-470 mc in 10 Bands**
- **Fundamental Frequency—Stable Narrow Band Sweeps**
- **Direct Reading Frequency Dial**
- **Highly Accurate Attenuators**
- **Sweep Repetition Rates Down to 10 cps**

The new *Vari-Sweep Model 400* is a highly versatile laboratory sweeping oscillator and signal generator. Its wide range of continuous frequency coverage from 15 to 470 mc is combined with a measure of accuracy and level of performance previously associated with limited, fixed-frequency-band oscillators only.

It provides frequency sweeps that are flat, wide, and linear. The RF output voltage is high enough for testing lossy networks without using additional amplifiers. Over the entire range, the RF output is a fundamental frequency held constant by a fast-acting AGC circuit to assure a high degree of frequency stability and the absence of spurious beat signals. The variable sweep rate goes down to 10 cps for checking high-Q circuits.

In addition, the *Vari-Sweep Model 400* is a source of accurately calibrated CW signal with the same high-level output AGC'd to be constant over the frequency band. This eliminates the need for readjusting output voltage when changing frequency, and permits the rapid testing of diverse frequency circuit elements under CW conditions.

SPECIFICATIONS

Frequency Range (CW or Sweeping Operation): Fundamental frequency, 15-470-mc, continuously variable in 10 switched, overlapping bands with direct-reading frequency dial.
Sweep Width: 60% of center frequency to 50 mc; at least 30 mc max from 50-400 mc; approx. 20 mc max above 400 mc.
Sweep Rate: Continuously variable, 10 to 40 cps; locks to line frequency.
RF Output: 1.0 V rms (metered) into nom 70 ohms (50 ohms on request) to 220 mc; 0.5 V rms to 470 mc. Output held constant to within ±0.5 db over widest sweep and frequency range by AGC circuit.
Attenuators: Switched 20, 20, 10, 6 and 3 db, plus continuously variable 6 db.
Sweep Output: Regular sawtooth, synchronized with sweeping oscillator. Amplitude 7.0 V approx.
Power Supply: Input approx. 100 watts, 117-V (±10%), 50-60 cps ac. B+ electronically regulated.
Dimensions: 9⅛" x 19½" x 13".
Weight: 34 lbs.
Price: $795.00, f.o.b factory.

NEW KAY *Rada-Sweep Sr.*

Single Unit Sweeping Oscillator in 10 Switched Bands **for Sweeping Radar IF's up to 350 mc Center.**

Cat. No. 386.

SPECIFICATIONS

Frequency Range: 1-350 mc center. 10 switched bands with fixed center frequencies set to customer specifications.
Sweep Width: 70% of center frequency from 1 to 100 mc. From 100 to 350 mc, 60 to 70 mc.
Sweep Rate: Variable around 60 cps. Locks to line frequency.
RF Output: 0.5 V rms into nom 70 or 50 ohms, higher for lower frequency units. Output held constant to within ±0.5 db over widest sweep by AGC circuit.
Zero Reference: A true zero-base line is produced on oscilloscope during retrace time.
Attenuators: Switched 20, 20, 10, 6 and 3 db plus continuously variable 6 db.
Markers: Up to 30 crystal-controlled positive-pulse markers at customer-specified frequencies. Accurate to ±0.05%. Up to three markers per band (more at lower frequencies) are available; no individual switches on markers.
Marker Amplitude: Continuously variable, zero to 10 V approx.
Sweep Output: Regular sawtooth synchronized with sweeping oscillator.
Power Supply: Input approx. 150 watts, 117 V (±10%) 50-60 cps. ac. B+ electronically regulated.
Dimensions: 8¾" x 19" rack panel, 13" deep. Supplied with cabinet; suitable for rack mount.
Weight: 34 lbs. approx.
Price: $795.00, f.o.b. factory. Add $15.00 per crystal marker ordered.

Write for 1958 Kay Catalog

KAY ELECTRIC COMPANY

Dept. E-5 **Maple Avenue, Pine Brook, N. J.** **CApital 6-4000**

TOO TOUGH TO DIE YOUNG..

Debugging*

INSURES LONG LIFE AND RUGGED RELIABILITY IN

El-Menco *Dur-Micas*

the LONGEST-LIVING CAPACITORS ever made!

TEST CONDITIONS	PERFORMANCE
El-Menco Dur-Micas and Conventional Molded Units . . . (same capacitance value, same case size) Subjected to life test under same voltage and temperature conditions for same period of time.	El-Menco Dur-Micas yielded 1/25 the number of failures that occurred in molded units.
DM30, 10,000 MMF, regular production "Undebugged" El-Menco Dur-Mica Capacitors . . . Subjected to life test of 10,000 hours at 85°C with 150% of the rated DC voltage applied.	Approx. 2.8% cumulative failures or 1 failure per 357,000 unit-hours.
DM30, 10,000 MMF, "Debugged" El-Menco Dur-Mica Capacitors . . . Subjected to life test of 10,000 hours at 85°C with 150% of the rated DC voltage applied.	0.6% cumulative failures or only 1 failure per 1,670,000 unit-hours.
DM30, 10,000 MMF, "Debugged" El-Menco Dur-Mica Capacitors . . . Subjected to 257,000 hours of life at 85°C with 100% of the rated DC voltage applied . . . computed.	Approx. 0.6% cumulative failures or 1 failure per 43,000,000 unit-hrs.

From Giant Electronic Brains to Tiny Transistor Receivers to Control Systems on Land, at Sea, in the Air.

EL-MENCO DUR-MICAS GIVE LONGEST LIFE TO ELECTRONIC EQUIPMENT

El-Menco Mica Capacitors can be debugged to eliminate early failures, thus insuring the highest dependability and an assured long life.

El-Menco Dur-Micas OUTPERFORM ALL OTHERS under accelerated conditions of 1½ times rated voltage at ambient temperatures of 125° centigrade . . . are *test-proved* to have longer life, most potent power, smaller size, excellent stability, peak performance.

DM15, DM20, DM30 . . . perfect for extreme miniaturization; ideal for new miniatured designs and printed wiring circuits.

New "hairpin" parallel leads insure easy applications in radios, TV, guided missiles, and other printed circuits. El-Menco Dur-Micas meet all humidity, temperature, and electronic requirements, including military specs. Write for FREE sample and catalog on your firm's letterhead.

* *Removal of Early Failures by Subjecting Mica Capacitors to a Short Life Test at Elevated Voltage and Temperature.*

THE ELECTRO MOTIVE MFG. CO., INC.

Manufacturers of El-Menco Capacitors

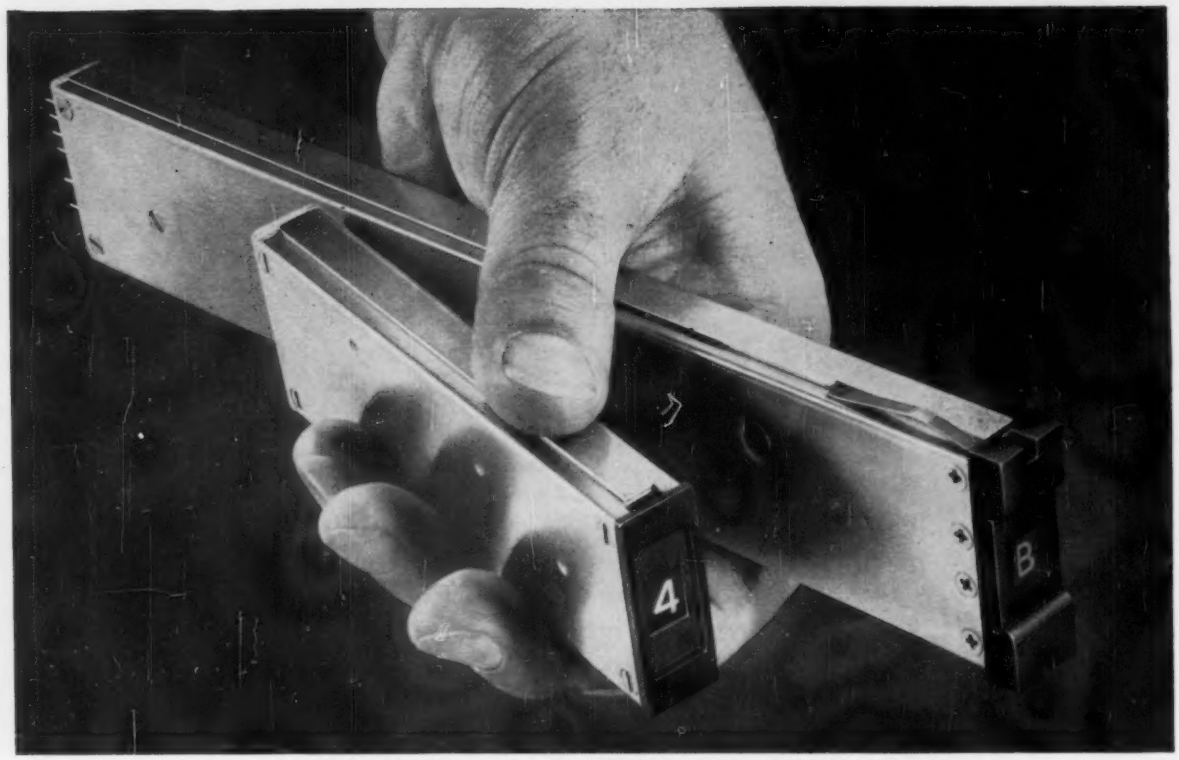
WILLIMANTIC CONNECTICUT

• molded mica • mica trimmer • dipped paper

• tubular paper • ceramic • silvered mica films • ceramic discs

Arco Electronics, Inc., 64 White St., New York 13, N. Y.
Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada

El-Menco *Capacitors*



Digital indicator (left) can display a possible 16 characters and is about half the size of the Alpha-numerical indicator (right) which displays 64 characters.

UNION INDICATORS
permit direct readout of binary data

UNION Digital and Alpha-numerical indicators are controlled by binary code signals employing a minimum number of control wires, and respond to simultaneous binary switching combinations.

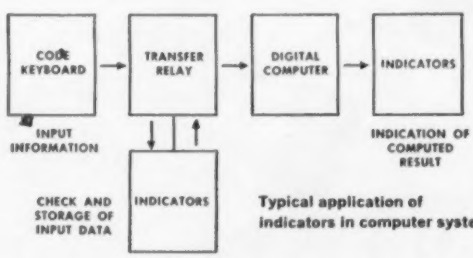
These indicators are electro-mechanical, D.C.-operated, readout devices for displaying characters in accordance with a predetermined code. The character display may be made to suit user's requirements.

Indicators are designed for plug-in mounting in a row so that data or messages of any desired length can be stored, displayed or transmitted at will. The indicators can be applied to the output of digital computers, teletype receiving equipment in conjunction with a buffer storage unit, telemetering systems, or wherever data needs to be displayed.

Two important features of these indicators are their inherent storage and transmitting characteristics which provide for data entry and retransmission. The indicators can be used to accept data from a source, free the source for other programs, and disseminate the data from one indicator to another as required. For each binary bit stored, an external relay can be eliminated.

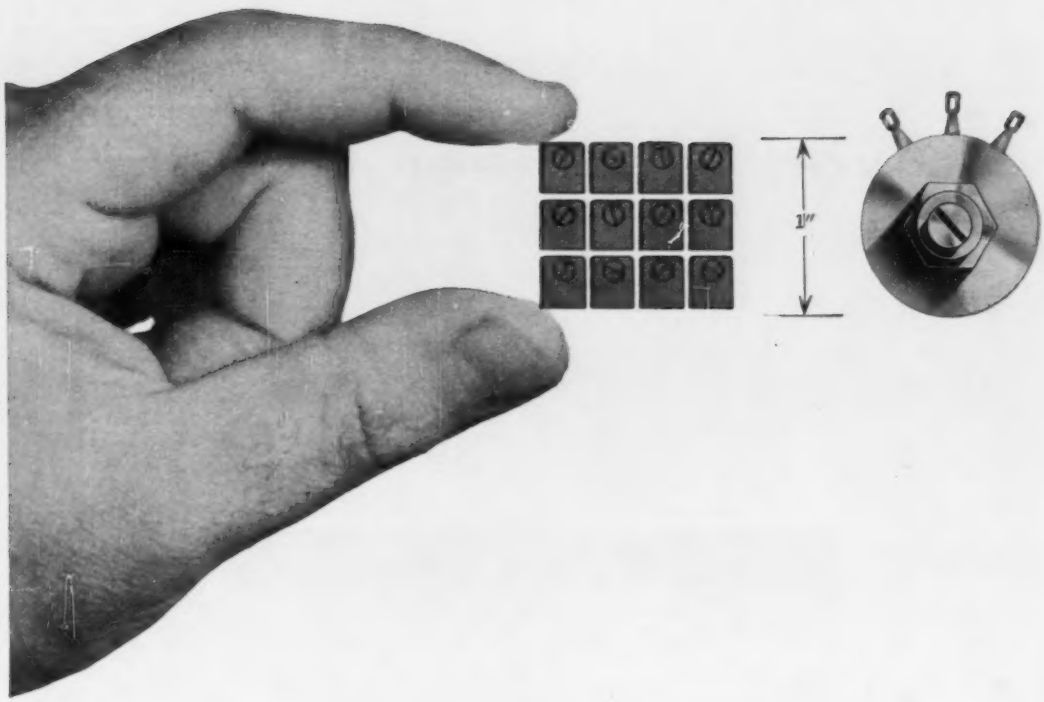
UNION indicators have provided economic and reliable advantages in data display applications associated with Air Traffic Control, Navigation, Telemetering, Fire Control and similar Airborne and Surface Instrumentation displays.

Write for Bulletin No. 1015 for complete information.



Typical application of indicators in computer systems.

UNION SWITCH & SIGNAL
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY
PITTSBURGH 18, PENNSYLVANIA



FIT 12 OF THESE RECTANGULAR POTENTIOMETERS IN A PANEL AREA OF 1 SQUARE INCH!

You can pack 12 Bourns TRIMPOT® potentiometers in the 1-square-inch area occupied by the average single-turn rotary.

Fit the TRIMPOT into corners—between components—flat against a chassis or printed circuit board. Mount them individually or in stacked assemblies. Any way you use them—Bourns potentiometers save space!

You can adjust Bourns potentiometers more accurately, too. The 25-turn screw-actuated mechanism gives you 9000° of rotation instead of 270°. Circuit balancing and adjusting is easier, faster. Repeatability is assured every time. Furthermore, adjustments are self-locking—shock, vibration and acceleration have no effect!

Write for new Model Summary Brochure

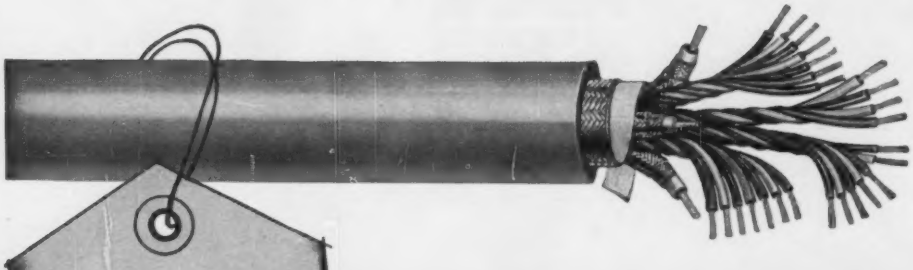
BOURNS
Laboratories, Inc.

P. O. Box 2112-A • Riverside, California

ORIGINATORS OF TRIMPOT® AND TRIMIT®
PIONEERS IN POTENTIOMETER TRANSDUCERS FOR POSITION, PRESSURE AND ACCELERATION

If it's worth engineers' time...

...it's worth engineered cable



Belden

TV CAMERA CABLE

Belden quality built to exacting specifications for black-and-white or color cameras. Harmonizing color—lightweight for easier handling.

MICROPHONE CABLE

A type for every requirement, designed for highest efficiency, easiest use, longest service life.

"Items from the Complete Belden Line"

Belden

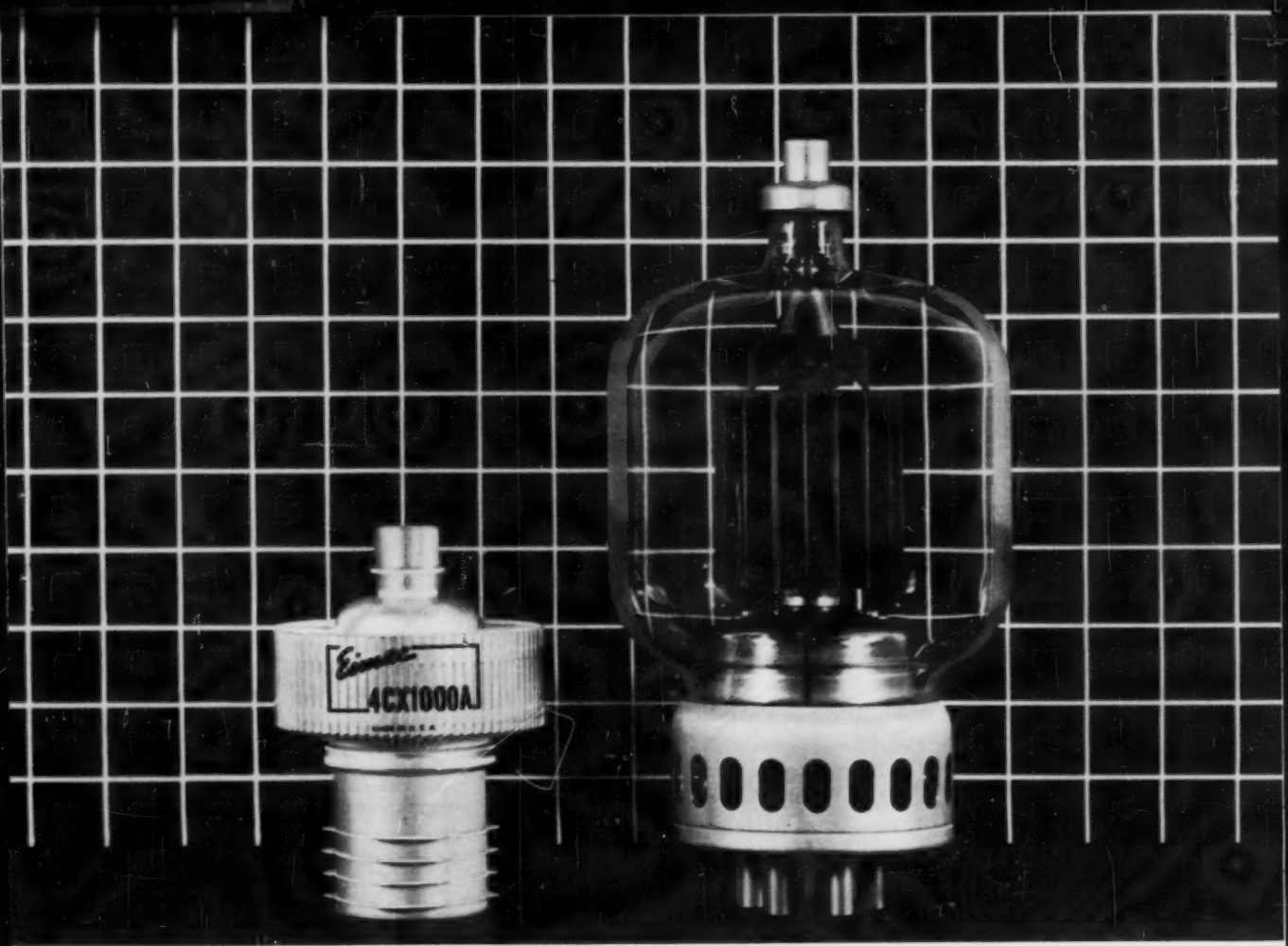
WIREMAKER FOR INDUSTRY
SINCE 1902
CHICAGO

5-8

Magnet Wire • Lead and Fixture Wire • Power Supply Cords, Cord Sets and Portable Cord • Aircraft Wires
Welding Cable • Electrical Household Cords • Electronic Wires • Automotive Wire and Cable

CIRCLE 22 READERS SERVICE CARD

CIRCLE 23 READERS SERVICE CARD →



Fourth in a series describing the advantages of ceramics in electron tubes. Previously discussed: Impact, Heat, Vibration.

Smaller Size

. . . is an Eimac Ceramic Tube Extra

Eimac ceramic tubes provide reliable power in small packages. The stacked ceramic 4CX1000A shown above — conservatively rated at one-thousand watts plate dissipation — is less than 5 inches high and 3½ inches in diameter. Compare it with the conventional glass tetrode of the same plate dissipation shown beside it.

The exceptional chemical and mechanical stability of ceramic material at high temperatures makes this compact, powerful tube possible. The higher temperature ratings of Eimac ceramic tubes make heat transfer more efficient and reduce cooling air requirements.

High power in a small package is just one of the many advantages of Eimac's stacked-ceramic design which now encompasses ⅓ of the Eimac product line. Other advantages are: resistance to damage by impact, vibration, or high temperature. In addition, the ability of ceramic tubes to withstand rigorous high temperature processing techniques leads to high tube reliability, uniformity and longevity.

In this incomparable line of ceramic tubes Eimac has the answer for the design engineer who needs a compact vacuum tube with high power handling capabilities.

Write our Application Engineering Department for a copy of the new booklet "Advantages Of Ceramics In Electron Tubes".

EITEL-McCULLOUGH, INC.

SAN BRUNO · CALIFORNIA

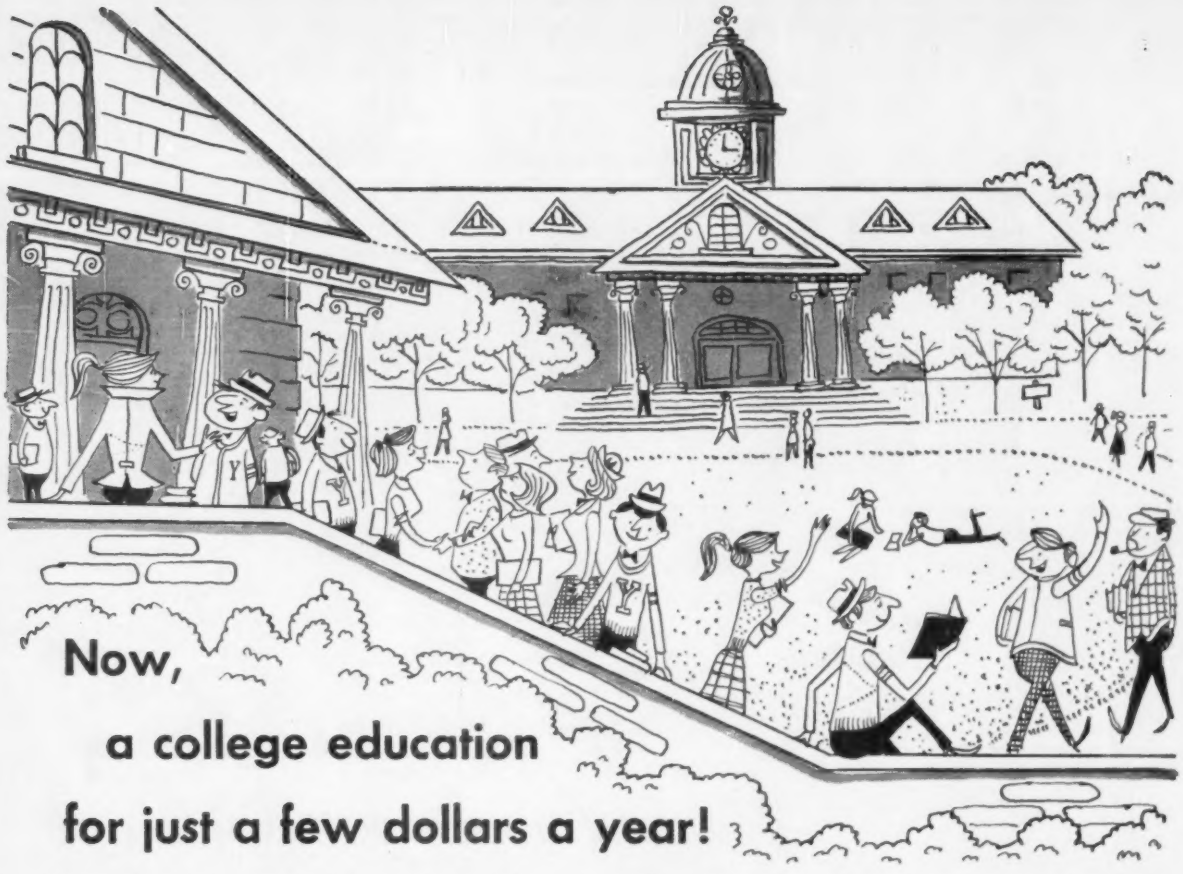
Eimac First with ceramic tubes that can take it

Eimac®

Eimac Designed and Manufactured Products

Negative Grid Tubes
Reflex and Amplifier Klystrons
Ceramic Receiving Tubes
Vacuum Tube Accessories
Vacuum Switches
Vacuum Pumps

Including more than 40 ceramic electron tubes.



Now, a college education for just a few dollars a year!

Some time ago, a man called your name, and you walked across a stage, and were handed a diploma. Were you proud! You were educated. The world was your oyster.

You promised yourself then that you would keep your education alive. That you'd go back and earn that graduate degree. Or brush up at night school, or some summer seminar. But then you met that pretty girl. A few years later – the stork, the new house on Cedar Road . . . everything seemed to happen at once.

Meanwhile, back on the job, you were busier and busier. Company expanding. New products. New problems. Nights when you got home, you were really beat. After dinner, you'd park yourself in your easy chair, find your mind wandering to the future – "Am I slipping? Is management passing me by?"

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Electron Tube News
– *from* SYLVANIA

Announcing the Sylvania Framelok Grid

. . . Introducing a New Receiving Tube Era

Sylvania's revolutionary Framelok construction marks the era of mass produced "Frame Grid" Tubes

Frame grid history is a Sylvania history

Beginning with its earliest handmade frame grid, Sylvania has concentrated engineering effort on frame grid design and development. From this experience, comes the Framelok Grid, a revolutionary design which makes it possible to mass produce frame grid tubes for the first time.

First tube to incorporate the Framelok Grid is the Sylvania Type 6FH6—a beam power pentode designed for Horizontal TV Deflection.

Framelok Grid is self-aligning

In the Framelok Type 6FH6, grid alignment is accomplished with unprecedented ease and precision. Sylvania's unique construction draws grid laterals taut; grid wires are arranged in a ladder sequence, normal to the axis of the grid. Precise frame construction and close mica tolerances make perfect alignment automatic.

Higher Plate-to-Screen Current Ratios

Framelok tubes are more efficient as a result of precise grid alignment. Plate-to-screen current ratios substantially greater than those of present types can be achieved—requiring less screen power for optimum performance. Thus improved horizontal scan performance can be realized.

Higher Dissipation

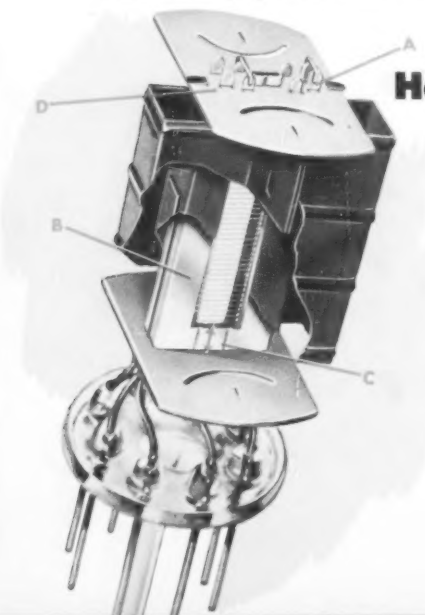
Less required screen grid power for a given plate power automatically reduces the dissipation requirements of the Framelok Grid. And since the Framelok Grid has greater mass it is more capable of dissipating heat. These factors, contributing to inherently lower grid emission, make it possible to achieve higher peak plate currents before dissipation becomes a limiting factor.

Mount is more rugged

Unlike ordinary grids, strength of the Framelok Grid comes from its rigid frame and is independent of the grid wires. This rigidity is transferred to the mount assembly, reducing life failures resulting from grid warping or bowing.

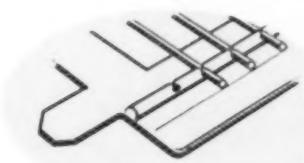
More uniform transfer characteristics

More precise grid construction, more uniform element spacings, and more rugged mount assembly,

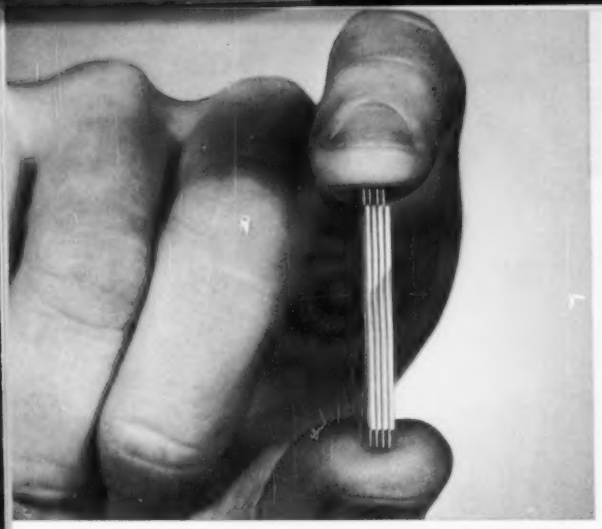


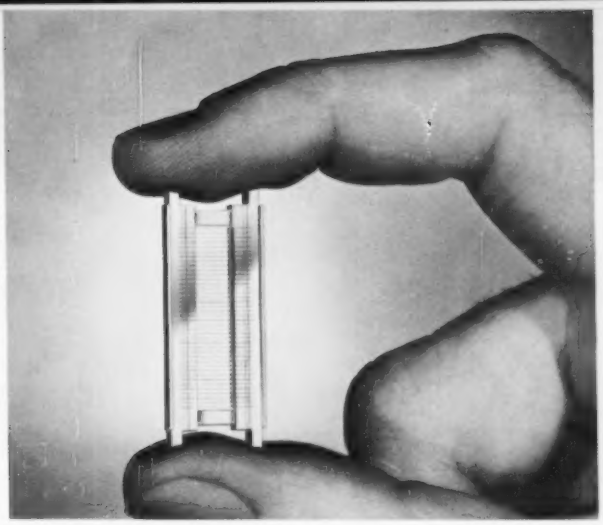
Here are a few highlights of the mechanical

A Straight line geometry of grid side-rods in present grids is considerably weaker than the double-box configuration formed by frame grids. Distortion due to mount "twist" is virtually nonexistent in the frame grid structure.



B Sylvania's new Framelok construction eliminates brazing and adapts the frame grid to automatic production. Grid halves are perfectly flat—free from thermal strains.





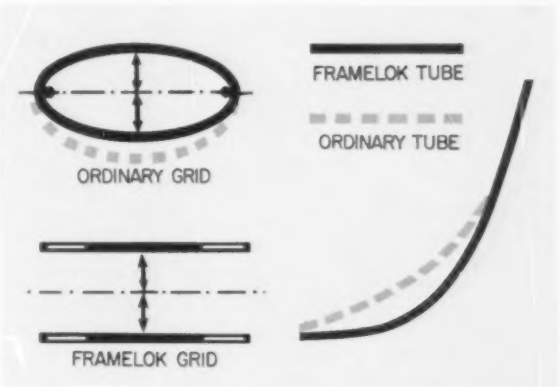
Many grids look like one! The inherent alignment capabilities of Sylvania's Framelok Grid are demonstrated by the ease with which the laterals of any number of separate grid halves can be lined up. Perfect alignment means higher efficiency—greater flexibility in the selection of grid wire diameters for optimum performance.

add up to closer control over tube transfer characteristics. Narrower control of limits of course means less critical circuitry, and a more stable and reliable performance in the end product.

Application potentials are wide

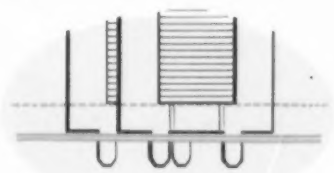
To meet the heavy operational requirements of horizontal deflection tubes, the first Framelok tube to be announced is the Horizontal Deflection Type 6FH6.

The adaptability of this grid is such that application of Framelok tubes should quickly extend to vertical TV deflection, video, audio, and a wide range of low and medium power uses in the frequency range below UHF.



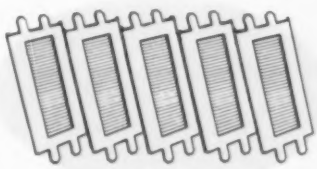
Uniform transfer characteristics of the Framelok Grid tube result largely from greater control of both major and minor dimensions of the grid. Above is a graphic representation of variations in characteristics which result from distortion of the minor dimensions in wound grids. Since both major and minor are fixed in the rigid frame grid, these variations are virtually eliminated.

superiority of the Framelok Tube



C Self-alignment is accomplished in the Framelok Grid through precise control of the distance between the mica and the first grid lateral wire. These tolerances in the frame grid are held in the order of one tenth of one thousandth of an inch—considerably tighter than ordinary grid tolerances.

D Mica slots are designed with flat alignment surface and channel index to position grids with much greater precision. Closer element spacings are possible where extra Gm is required.



Sylvania's unique technique of frame grid construction makes it possible to duplicate grid after grid. More uniform spacings produce a more uniform electrostatic field in the tube.

The SYLVANIA

FRAMELOK

TYPE 6FH6

Highly efficient horizontal deflection tube

Proved in pilot and now being planned for mass production, the Framelok Type 6FH6 is the most efficient tube ever designed for horizontal deflection service.

It provides design engineers with a new flexibility in circuit design because of the high zero-bias plate-to-screen current ratio. This permits the tube to be driven harder at a lower screen dissipation.

The 6FH6 supplies increased power output because plate voltage can swing to a very low value without encountering unduly high screen grid currents. Higher screen voltages can be maintained at lower dissipation levels resulting in higher output peak current and power.

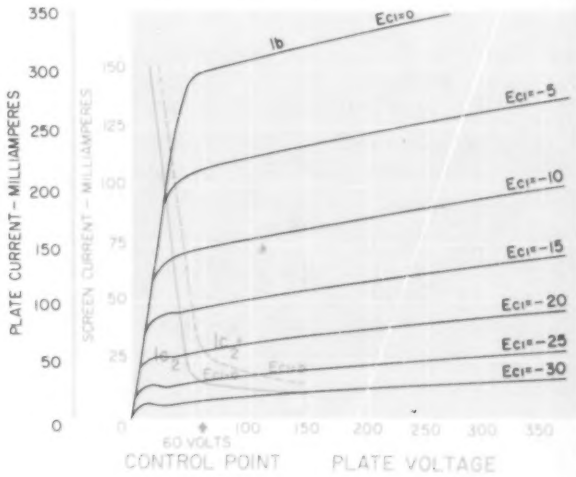
TYPE 6FH6
DESIGN MAXIMUM RATINGS

Maximum D. C. plate supply voltage (boost + DC power supply)		770	volts
Maximum peak positive plate voltage		6000	volts
Maximum peak negative plate voltage		1500	volts
Maximum plate dissipation		17	watts
Maximum D.C. grid #2 voltage		220	volts
Maximum peak negative grid #1 voltage		300	volts
Maximum grid #2 dissipation		3.6	watts
Maximum average cathode current		135	ma
Maximum peak cathode current		500	ma
Maximum grid #1 circuit resistance	Self-bias	1.0	megohm
Maximum bulb temperature (hottest spot)		240	°C

AVERAGE CHARACTERISTICS

Pentode operation with Eb=250 V; Ec2=150 V; Ec1= −22.5 V;		
Plate current	75	ma
Grid #2 current	1.7	ma
Transconductance	6000	umhos
Plate resistance	12,000	ohms
Zero Bias with Eb=60 V; Ec2=150 V; Ec1=0; (instantaneous values)		
Plate current	300	ma
Grid #2 current	15	ma
Cutoff: For Ib=1.0 ma with Eb=250 V; Ec2=150 V.		
Grid #1 voltage (approx.)	-53	volts
Triode Amplification Factor with Eb=Ec2=150 V and Ec1= −22.5 V	4.1	

Framelok type 6FH6 plate-to-screen current ratios are compared to those of comparable existing tubes.



Type=6FH6
Avg. Plate Characteristics
Ef=Rated Voltage

Ec2=150 V DC
Ic2=6FH6 Framelok Structure
Ic2*=Conventional Structure

For additional information on Framelok Tubes and the Type 6FH6 mail this coupon to:

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1740 Broadway
New York 17, N. Y.

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Company_____

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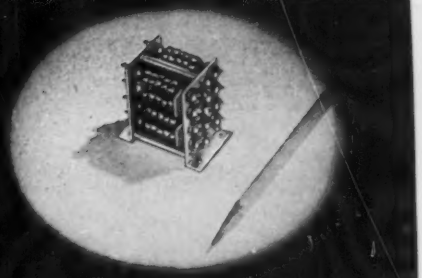


8 circuit miniaturized filter for wide band RF Interference Suppression.

IF YOURS IS A TOUGH RF INTERFERENCE PROBLEM—LET FILTRON SOLVE IT . . . .

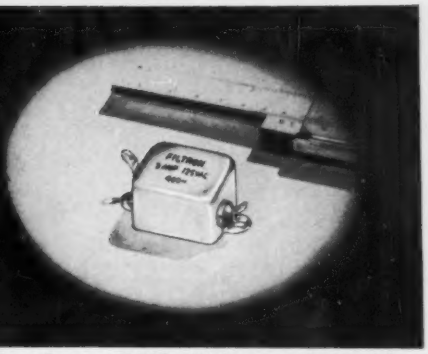
FILTRON'S engineering department, cooperating with engineers of leading companies, has solved RF Interference Suppression problems throughout the country.

If your equipment must meet the RF Interference limits set by the military specifications, consult with FILTRON'S engineers in the earliest stages of design. FILTRON can furnish RF Interference Suppression Filters whose size, weight and overall configuration will fit into your equipment.

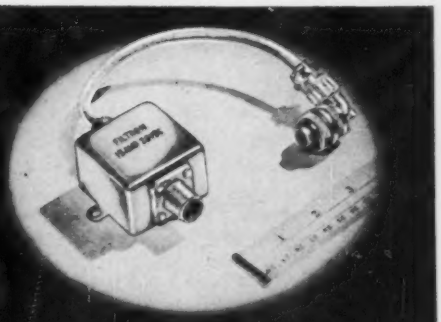
FILTRON has *custom designed* over 1000 different types of RF Interference Suppression Filters for equipment that meets military RF Interference Suppression limits and specifications.

FILTRON'S completely equipped screen rooms are always available for the RF Interference testing of your units and equipment.

An inquiry on your company letterhead will receive prompt attention.



Miniature 3 amp.–125 VAC–400~ filter–hermetically sealed–size 1⅛" x 1" x 1⅝"



15 amp.–28 VDC filter, size 2" x 2" x 1¼", with pressurized AN connectors–high attenuation from 150 KC to 400 MC.

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- **FILTRON'S modern shielded laboratories are equipped to measure RF Interference from 14 KC to 1000 MC in accordance with military specifications.**
- **FILTRON'S production facilities, comprising a capacitor manufacturing division, coil winding division, metal fabrication shop, metal stamping and tool and die shops, are exclusively producing the highest quality components for FILTRON'S RF Interference Suppression Filters.**
- **FILTRON'S extensive production facilities permit us to meet your delivery requirements. NOW!**

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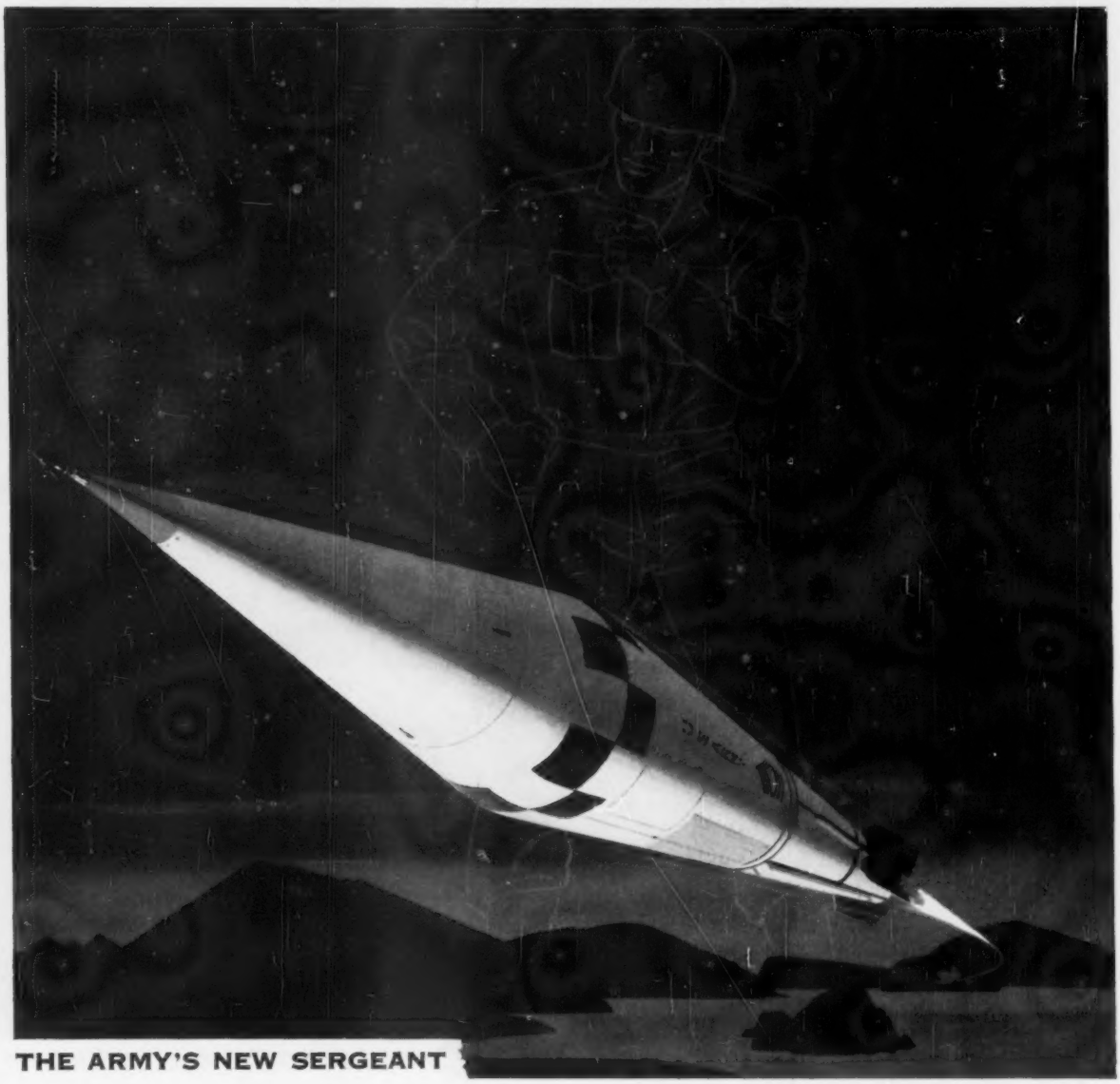
NOTABLE ACHIEVEMENTS AT JPL...



THE ARMY'S NEW SERGEANT

JPL is proud to have the responsibility of designing and developing the U.S. Army's newest operational missile system—the Sergeant. This weapon is America's first truly "second generation" surface-to-surface tactical missile and, when placed in production will eventually succeed the Corporal which was also a JPL development.

The Sergeant, especially designed as an extremely mobile tactical weapon, utilizes a solid propellant rocket motor which provides better field handling and storage capabilities than those of many other weapon systems. It can deliver a nuclear blow deep into enemy territory and its highly accurate guidance system is invulnerable to any known means of enemy countermeasure.

All elements of the Sergeant are particularly designed for active field use with emphasis on reliability, mobility and the use of standard U.S. Army vehicles wherever possible. The erector-launcher, for example, is capable of rapid movement over rough terrain. These characteristics place in the hands of the U.S. Army an important new tactical element of extended range.

The basic activity at JPL continues to be—research into all scientific fields related to the development of weapons systems and space research vehicles.

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This equipment, available only from Narda, provides the most convenient means for evaluating the residual VSWR of coaxial slotted lines. VSWR of the element is 1.05 or less; covers range from 2000 to 12,400 mc.

N Connector, male or female **$110** C Connector, male or female **$116**

MODEL 371 FIXED COAXIAL TERMINATION

This Narda coaxial termination is the first and only to cover the entire frequency range from S to X band. Same range and element VSWR as above.

N Connector, male or female **$55** C Connector, male or female **$58**

3, 6, 10 and 20 DB

40 DB HIGH POWER

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The 40 db High Power Coupler is another exclusive Narda product. Similar to standard types, except that coupling irises are in the narrow wall, it may be used at full rated power of the waveguide size. Nominal coupling value is 40 db; directivity 40 db. Directivity for 3, 6, 10 and 20 db couplers is also 40 db. Standard cover flanges on primary line; low VSWR termination and standard cover flange on secondary. All bands covering frequencies from 2600 to 18,000 mc.

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Narda offers five values of reflections for each of six different waveguide sizes . . . the most complete choice we know of! Provides calibrated reflections or VSWR's for use in standardizing reflectometers or calibrating slotted line impedance meters.

SPECIFICATIONS

Reflection Coefficient	0.00	0.05	0.10	0.15	0.20
Accuracy	0.002	0.0025	0.0035	0.0045	0.007
VSWR Equivalent	1.00	1.105	1.222	1.353	1.50

Models for 2.60 to 18.0 kmc, from $125 to $300

Microwave engineers–

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Other features include angle-mounted scale and vernier for optimum visibility; readily removable supporting pedestal; and smooth carriage travel action. Waveguide models, accurate for VSWR's of 1.01, are available for complete coverage from 2600 to 18,000 mc; N or C Connector coaxial models, from 1500 to 12,400 mc.

WAVEGUIDE IMPEDANCE METERS

Frequency (kmc)	Narda Model	Residual VSWR	Price
2.6 — 3.95	224	1.01	$425
3.95— 5.85	223		350
5.3 — 8.2	222		325
7.05—10.0	221		270
8.2 —12.4	220		250
12.4 —18.0	219		270

COAXIAL IMPEDANCE METERS

Frequency (kmc)	Connectors (One Male, One Female)	Narda Model	Price
1.5 to 12.4	Series N	231	$360
1.5 to 12.4	Series C	232	390

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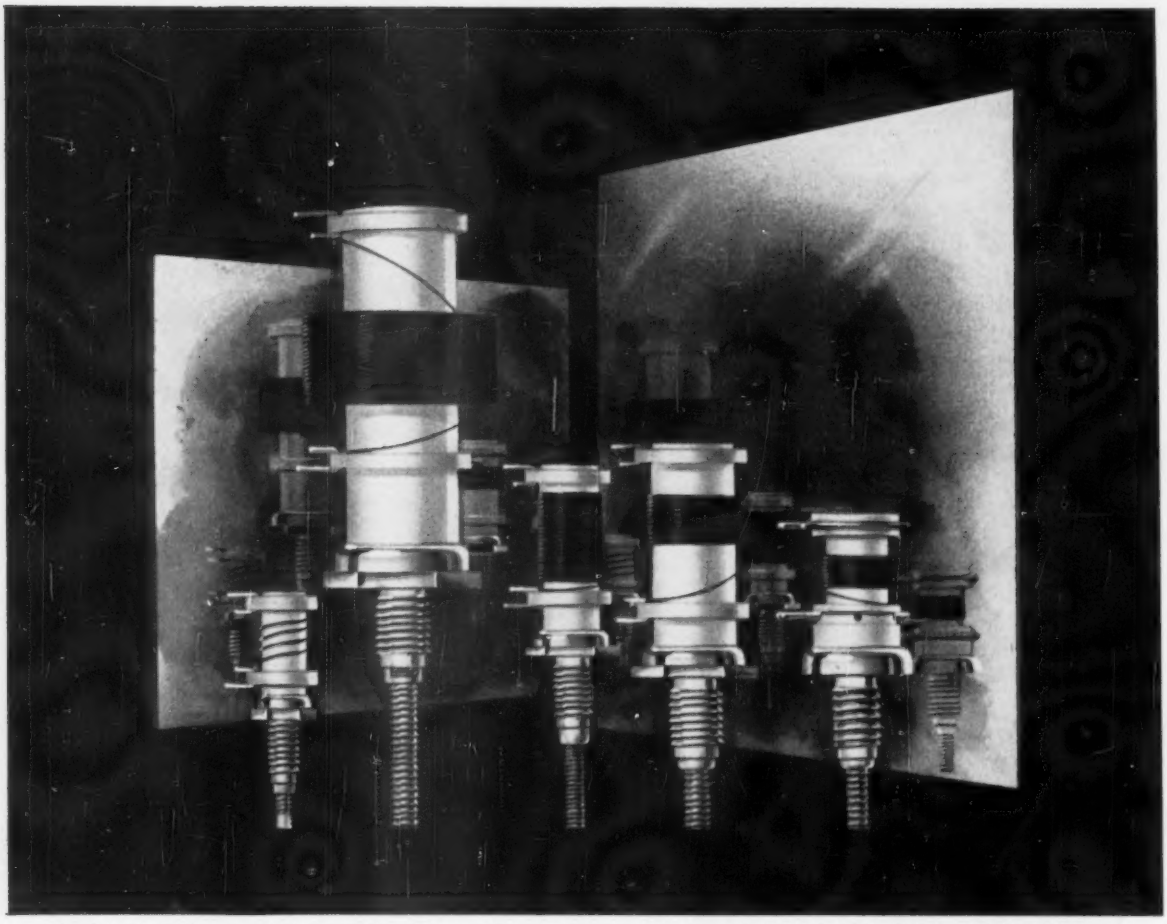


Cambion® coil forms with Perma-Torq*® Tensioning Device are designated PLST, PLS-6, PLS-5, PLS-7, PLS-8 and are factory assembled to mounting studs. The units are completely interchangeable with Cambion's LST, LS-5, LS-6, LS-7 and LS-8.

Reliability is their family resemblance

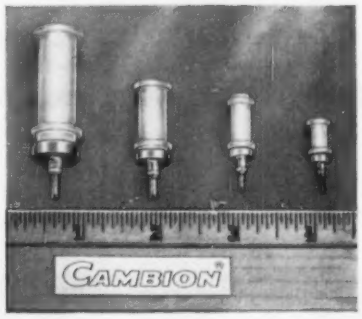
Here's a reliable family of coil forms ready to meet your specifications. These Perma-Torq Tensioning Devices on Cambion coil forms allow locking of tuning cores while still tunable — and you can depend upon them to do their job well.

This built-in dependability is a result of Cambion's unique design plus quality control — that meets or betters government specifications.

Perma-Torq is a compression spring of heat treated beryllium copper, that has a very high resistance to fatigue and keeps coils tuned as set — even under extreme vibration and shock. The device also allows for immediate readjustment — without removal or loosening of any mounting nut or locking spring.

Quality control and features like the above are just two of the reasons why Cambion can offer you guaranteed standard or custom electronic components — whose performance you can rely upon.

Cambion researchers and practical experts are always available to help you solve your component problems. For all specifications and prices, write Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast stocks maintained by E. V. Roberts and Associates, Inc., 5068 West Washington Blvd., Los Angeles 16, and 1560 Laurel St., San Carlos, Calif.



Cambion's new printed circuit coil forms are ideal for high temperature work and horizontal mounted panels. Equipped with Perma-Torq locking device for set tuning, the tuning core is affixed to the form at one end through a brass housing, thus eliminating internally threaded forms and cores and resulting in a more precise element with finer tuning. The coils, 2550, 2540, 2530 and 2525, are ceramic units with silicone fiberglas collars which have terminals for mounting on printed circuit boards.

*Patent pending.

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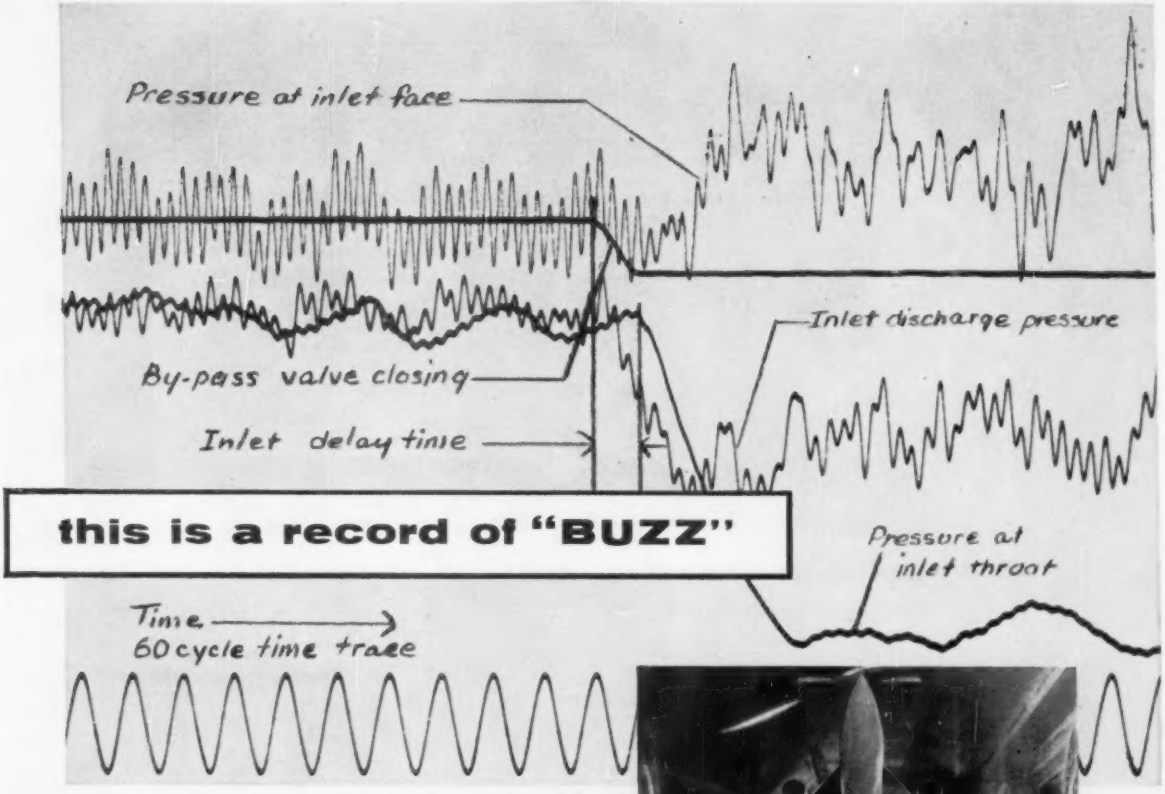
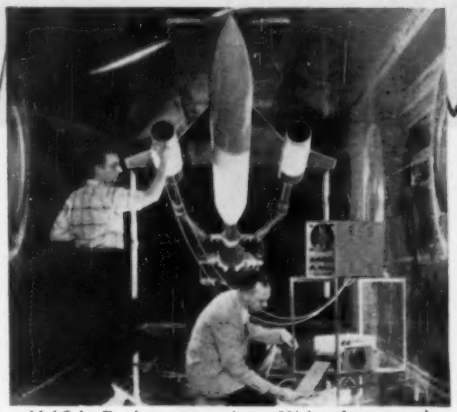


The Visicorder charts pressure fluctuations in a supersonic inlet

A Model 906 Honeywell Visicorder wrote this record of pressure fluctuations . . . "buzz" . . . for the National Advisory Committee for Aeronautics at the Lewis Flight Propulsion Laboratory in Cleveland. Buzz is the term used to describe unsteady variation in pressure and airflow characteristics of a supersonic aircraft or missile inlet.

The purpose of these Visicorder studies is to define the buzz-free operating limits of the inlet, and to provide the designer with structural load information in case the inlet is inadvertently caused to operate on buzz during flight. This is particularly important because inlet buzz can result in fluctuating structural loads of the order of 1000 psf. Depending on the inlet design, this could cause structural failure of the inlet and loss of the airplane.

High response pressure transducers are used to measure these fluctuating pressures and the resulting electrical signal is fed into the Visicorder. Records such as this are also necessary in the determination of the inlet dynamics such as delay time. This information is then used to design inlet control systems.



NACA Engineer examines Visicorder record

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Low-level up to 2 amps at 29 volts d-c, 1 amp at 115 volts a-c 400 cps non-inductive or 0.5 amp inductive.
Life—100,000 minimum at 125°C

Also available 3 amps at 29 volts d-c, 2 amps at 115 volts a-c 400 cps non-inductive or 1 amp inductive.
Life—100,000 at 3 amps or 500,000 minimum at 2 amps at 125°C.
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Contact Drop—1 millivolt maximum at low level rating, initial and during low level miss test

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D-C Coil Resistance—up to 10,000 ohms
Nominal Power—1.2 watts
Pull-in Power—240 milliwatts (standard)
100 milliwatts (special)
Operate Time—5 milliseconds max.
Release Time—3 milliseconds max.

Dielectric Strength:

1000 volts rms at sea level
500 volts rms at 70,000 feet
350 volts rms at 80,000 feet

Insulation Resistance:

10,000 megohms minimum at 125°C

ENVIRONMENTAL FEATURES

Vibration:

5 to 10 cps at 0.5 inch double amplitude
10 to 55 cps at 0.25 inch double amplitude
55 to 2000 cps at 20 g
Shock: 100 g's operational • 200 g's mechanical
Ambient Temperature: −65°C to +125°C

MECHANICAL FEATURES

Weight: 0.5 ounces

Terminals:

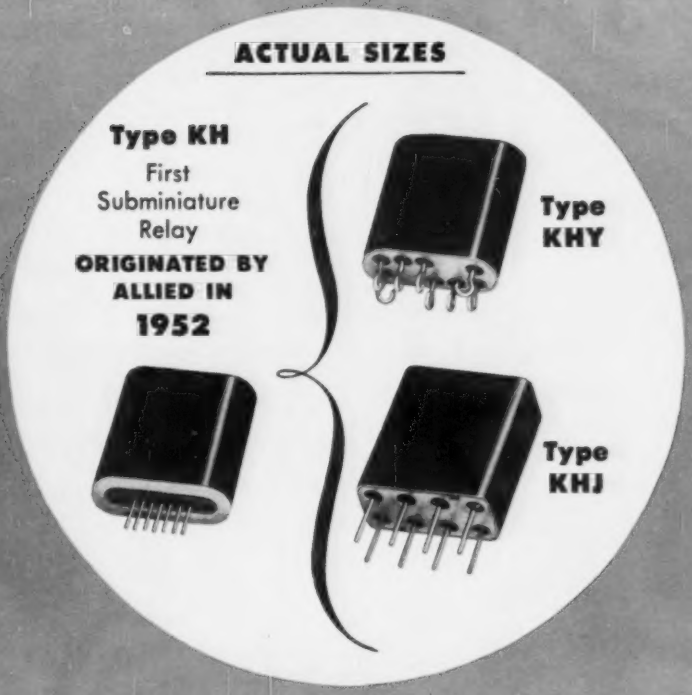
Hooked Solder • Plug-in • Printed Circuit

Mountings:

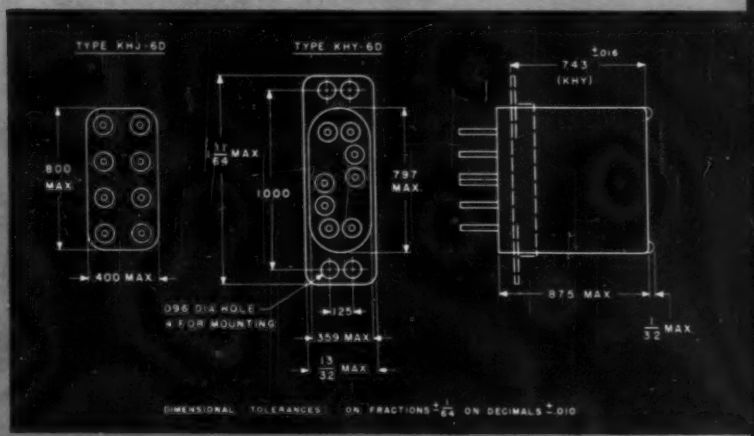
2 or 4 hole brackets at base or center of gravity
1 or 2 stud on top or side of housing

MILITARY SPECIFICATIONS

MIL-R-25018 • MIL-R-5757C



Allied's type KHJ and KHY subminiature relays were developed to meet the present "Automation" need for relays with incremental grid spaced terminals and with improved performance. These relays have a higher contact rating and are designed to meet the increased vibration and shock requirements of the latest MIL specs. They are available with mounting brackets that are interchangeable with Allied's present type KH subminiature relay.



ALLIED CONTROL

ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, N. Y.

AL-100

The 6116/TE-39 ruggedized Reflex Klystron thermally tunes a band of 8500 to 9660 MC by means of a diode within the vacuum envelope. Tuning speed over the required frequency range is 0.7 seconds min. to 3.0 seconds max.

The 6940/TE-58 is identical to the 6116, but has special characteristics limiting spectrum width and spectrum continuity under adverse load conditions.

The 6845/TE-59 is similar in electrical and mechanical characteristics to the 6116 but may be operated under pulsed conditions with minimum frequency modulation.

BENDIX RUGGEDIZED REFLEX KLYSTRONS WITH THERMAL TUNING

The 6116/TE-39 Klystron tube combines ruggedized construction and *thermal tuning*. The combination provides a desirable tube for use in air-borne radar and similar applications. Ruggedization makes possible a frequency jitter of less than ± 1.3 MC . . . at vibration levels up to 10 G at 50 cps. Thermal tuning provides a twofold advantage. It permits tuning the tube over its entire operating frequency remotely without mechanical means—and the tube can be repeatedly cycled throughout its tuning range without damage or deterioration.

These Reflex Klystrons are but one example of how Bendix Red Bank technology can help you meet specialized tube needs. For information on these tubes . . . and on backward-wave oscillators and traveling-wave tubes . . . write RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

West Coast Sales & Service:
117 E. Providencia Ave., Burbank, Calif.

Export Sales & Service: Bendix International Division,
205 E. 42nd St., New York 17, N.Y.

Canadian Distributor: Computing Devices of Canada, Ltd.,
P.O. Box 508, Ottawa 4, Ontario

Red Bank Division

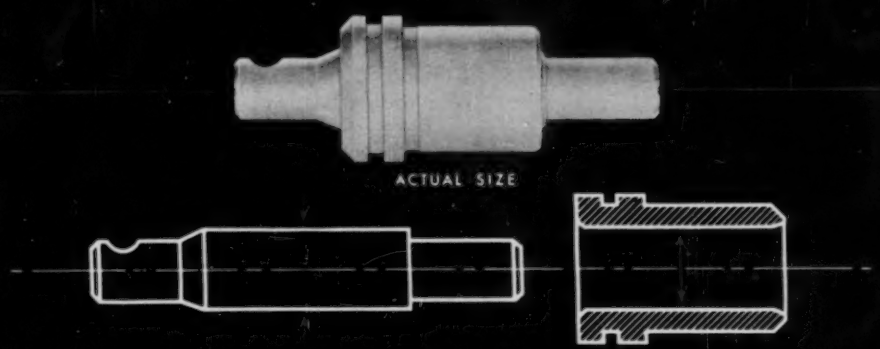
Bendix
AVIATION CORPORATION

CIRCLE 30 READERS SERVICE CARD

CIRCLE 31 READERS SERVICE CARD →

Coors CERAMICS

HIGH PRECISION TOLERANCES



SHAFT		BUSHING	
Diameter	0.000015	Diameter	0.000050
Taper	0.000010	Taper	0.000010
Camber	0.000010	Camber	0.000010
Out-of-Roundness	0.000010	Out-of-Roundness	0.000010

BENDIX AVIATION CORPORATION SHAFT AND BUSHING ASSEMBLY

VERY CLOSE TOLERANCES AND CLEARANCES ON ASSEMBLY PROVIDE FRICTION FREE ACTION

Coors Alumina Ceramic is used in production quantities by the Bendix Aviation Corporation for a shaft and bushing assembly that has tolerances as close as ±0.000015. From one bushing to another, Coors holds the diameter to ±0.000050. Between one shaft and another, Coors holds the diameter to ±0.000015. On both bushings and shafts, taper, camber and roundness of individual parts are held to 0.000010 total.

Extremely close, match-fit sets of this assembly are made by selective fitting. Finishing within a few millionths is required to provide proper fits—exact clearance must be withheld.

These very close tolerances and clearances provide friction free action between the shaft and bushing. This, combined with the hardness and chemical inertness of the alumina ceramic, gives the assemblies long, trouble free service.

Guaranteed precision on a production basis permits the engineer to use Coors ceramics in applications where the physical properties of metals and plastics are unacceptable. Tolerances and finishes which can be obtained by Coors are:

Diametrical.....within 0.000030" total.
Taper.....0.000010" per inch of length*.
Camber.....0.000010" per inch of length*.
Out-of-roundness.....0.000010".
Surface flatness—less than 1 light band.
Equivalent surface finish—
3 to 4 r.m.s. microinch.

*(in lengths up to 3 inches)

For a complete description of physical properties of Coors High Alumina Ceramics, write for Bulletin 1055A.

COORS PORCELAIN COMPANY

Manufacturers of High Strength Alumina Ceramics
GOLDEN, COLORADO

COORS PORCELAIN CO., 616 9th St., Golden, Colo.
Please send me detailed Bulletin 1055A on Coors High Strength Alumina Ceramics and Coors manufacturing facilities.

Name.....Title.....
Company.....
Address.....
City.....State.....

Please refer to our 12-page catalog in Sweet's Product Design File

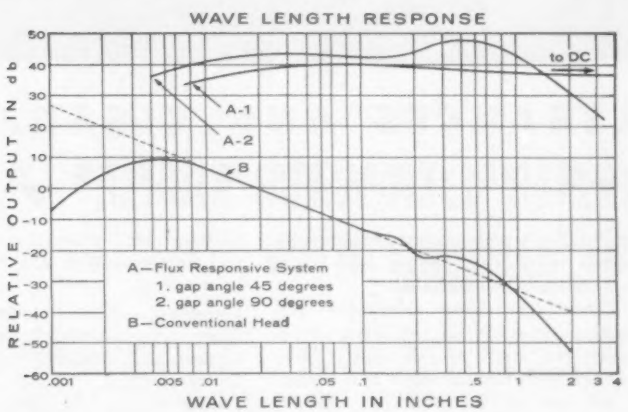
CLEVITE 'BRUSH'
Flux-Responsive Magnetic Heads

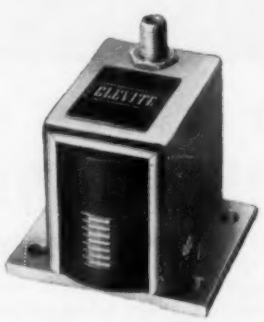
REDUCED BUFFER STORAGE EQUIPMENT, FASTER DATA ACCESS, EARLIER RELEASE OF MAIN COMPUTER

Clevite "Brush" Flux-Responsive Heads respond to the magnitude of signal flux instead of the rate of flux change. Output of flux heads is independent of tape or drum speed and, therefore, independent of frequency or pulse repetition rate. The signal reproduced by the flux-responsive head is an accurate facsimile of the recorded flux pattern and of the original recorded information.

The output of a computer, recorded at high speed, can be played back later at much slower speeds with a flux-responsive head to exactly match the relatively slow processing rate of typewriters, card punching machines and other output devices. Clevite Flux-Responsive Heads can also operate in the conventional manner. This permits one head to search recorded data at high speed, locate it, and then be switched to flux-responsive operation for operating of output devices.

Special flux-responsive heads have been developed by Clevite to meet specific customer applications. They are now commercially available in 1 to 32 channel form in a variety of mechanical configurations. These designs, slightly modified, may fit your present requirements. One of our specialists will be pleased to discuss your application by detailed correspondence or personal visit. Write: Product Manager, Magnetic Heads, Clevite Electronic Components, 3311 Perkins Avenue, Cleveland 14, Ohio.





Typical Clevite multi-channel flux-responsive head, with .032 in. track and .070 in. spacing.

Clevite 'Brush' Flux-Responsive Heads for low speed or static read-out of digital information • reproduction of high frequency analog recording at low tape speeds • extended-period process control • reproduction of low frequency recording • measurement of low angular or low linear velocities and recorded transients • position control

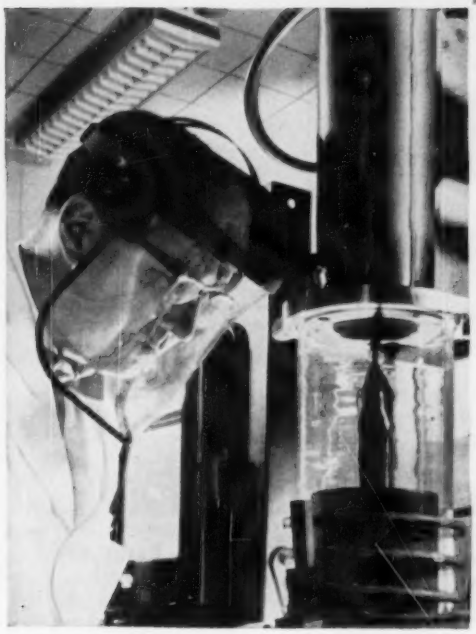
CLEVITE ELECTRONIC COMPONENTS

DIVISION OF CLEVITE CORPORATION

MAGNETIC HEADS
TRANSDUCERS
PIEZOELECTRIC CRYSTALS, CERAMICS AND ELEMENTS

CIRCLE 32 READERS SERVICE CARD

DELCO HIGH POWER TRANSISTORS are made from



In the center of the quartz housing, a germanium crystal is being grown. A "perfect crystal lattice," it will be cut into wafers 3/10ths of an inch square and less than 1/100th of an inch thick to become the heart of Delco High Power transistors.

GERMANIUM

because it <u>alone</u> combines these 5 advantages:

Lower saturation resistance—Germanium gives Delco High Power transistors a typical saturation resistance of only *3/100ths* of an ohm. No other present material offers this characteristic, which permits efficient high-power switching and amplification from a 12- or 24-volt power supply.

Higher current gain—Gain with germanium is not only higher but is more linear with current.

Lower distortion—In many applications, distortion requirements can be satisfied only with germanium transistors.

Lower thermal gradient—As far as deliverable power of present devices is concerned, germanium meets the need and, in addition, provides a thermal gradient of only 1.2° C/watt.

Greater economy—More power per dollar.

DELCO RADIO

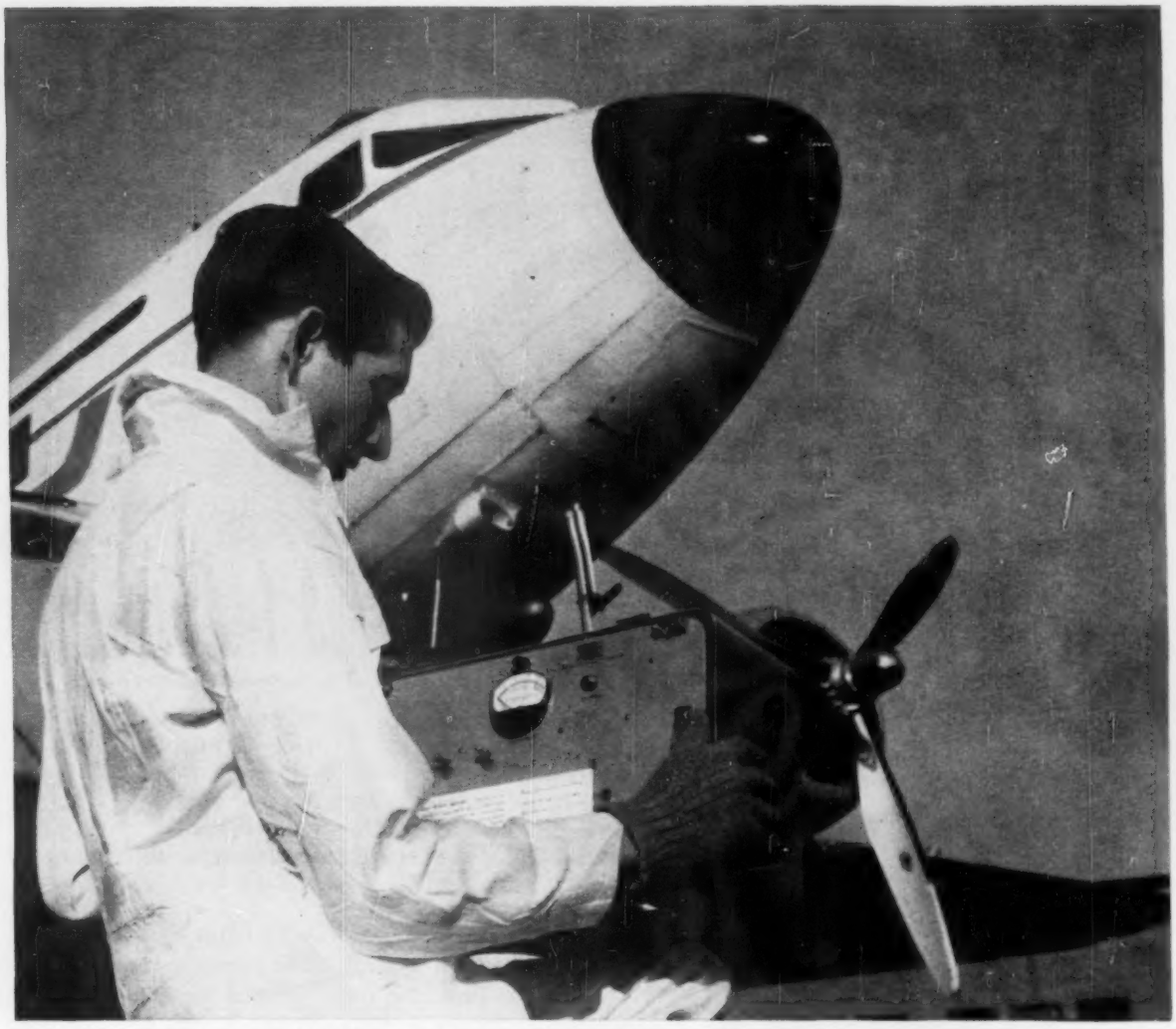
Division of General Motors, Kokomo, Indiana

BRANCH OFFICES

Newark, New Jersey
1180 Raymond Boulevard
Tel.: Mitchell 2-6165

Santa Monica, California
726 Santa Monica Boulevard
Tel.: Exbrook 3-1465

Examine Delco High Power germanium transistors and see how practical it is to go ahead with your plans now. For high current applications there is no better material than germanium, or Delco Radio would be using it. All Delco High Power transistors are produced in volume; all are normalized to retain their fine performance and uniformity regardless of age. Write for engineering data and/or application assistance.



Panel light indicates when radar's ring time exceeds predetermined standard.
Other checks can be obtained with frequency indicator and relative power meter.

New portable radar tester makes fast "go, no-go" check

Tests all radars aboard aircraft, requires no training to operate

Here's the fastest means yet developed for testing aircraft radar on the flightline or in the field. It's the new Sperry Microline® Radar Performance Tester and anyone can use it—no special training is required.

Weighing only 24 pounds (30 for C-band), this tester is self-powered (standard batteries) and is easily carried about. It prevents costly delays by providing a quick, over-all check of all aircraft radars in only minutes.

This is the only performance tester that checks the alignment between transmitter and receiver positively and accurately by flipping a single switch. Interchangeable plug-in echo box cavities permit checking either C or X-band radars. Transistorized circuits with built-in testing feature contribute to light weight and reliable performance.

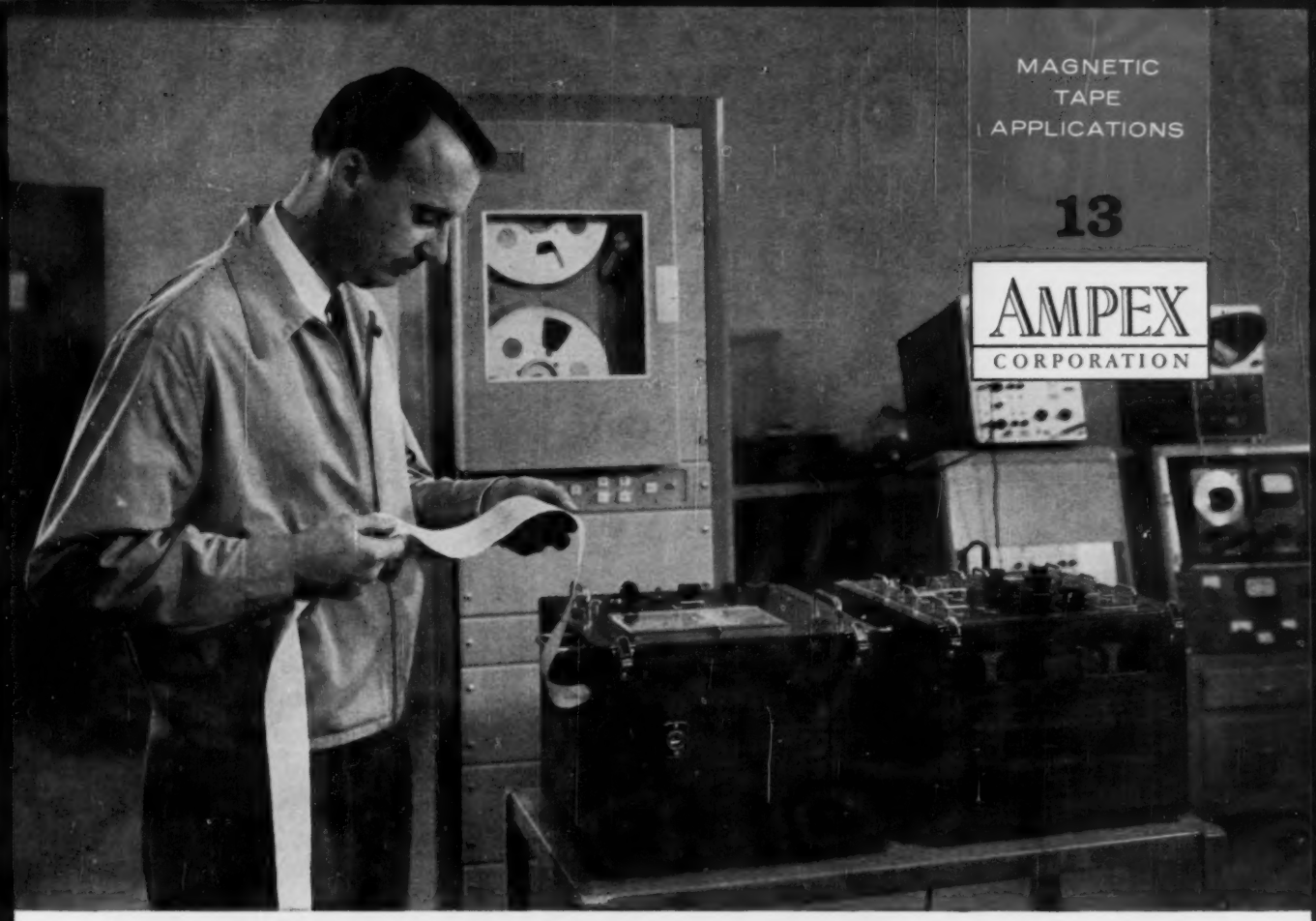
If you'd like to know more about the new Sperry Microline Radar Performance Tester, write our Microwave Electronics Division.

MICROWAVE ELECTRONICS DIVISION

SPERRY GYROSCOPE COMPANY
Great Neck, New York

DIVISION OF SPERRY RAND CORPORATION

BROOKLYN • CLEVELAND • NEW ORLEANS • LOS ANGELES
SAN FRANCISCO • SEATTLE. IN CANADA: SPERRY GYROSCOPE
COMPANY OF CANADA, LIMITED, MONTREAL, QUEBEC.



How to write 10,000-cycle data on a pen recorder

A tape tie-in banishes frequency-response limitations and saves paper

We will cancel the laws of physics, throw out inertia, and behold here is a pen recorder writing out 10,000 cycles per second ready to read. Don't scoff. There is a way. Assuming visual data is really what you want, keep your eye on the oscillograph or pen recorder, and think of the tape recorder as an ingenious "frequency-response extender" or "data stretcher."

A SLOW-MOTION LOOK AT TRANSIENTS

When an aircraft manufacturer was having shock problems from the firing of an experimental plane's armament, nothing could be seen in real-time data. For a better look, shock waves were recorded on tape, slowed down, recopied and then written out in visual traces. A thousandth of a second was stretched out to a full second. The exact extent and nature of the shock pattern and its manner of transmittal through the plane's structure became clearly evident – and with it the design solution.

100-TO-1 DATA STRETCHOUT (and more)

Compared to any visual-trace recorder, an Ampex instrumentation tape recorder has virtually unlimited response. Frequency components as high as 10,000 cycles per second (and much more) are easily recorded. And tape has decided advantages too at 1000 or 2000 cycles. A tape speed of 60 inches per second captures any of these higher frequencies and has tremendous room for slowdown on playback. Reproducing the tape at 0.6 in/sec. reduces 10,000 cps. to a mere 100. Connect a direct-writing recorder to the tape recorder and 100 cycles response is all that you need.

Actually Ampex has a wide range of tape speeds and tape slowdown ratios available. Tapes can be recopied once or even twice multiplying these ratios accordingly.

TYPICAL TAPE SLOWDOWN (OR SPEEDUP) RATIOS			
AMPEX MODEL	Basic speed ratio	First recopy	Second recopy
FR-1100	8 to 1	64 to 1	512 to 1
FR-100	32 to 1	1024 to 1	32,768 to 1
FR-1100 multirange (many versions available)	100 to 1	10,000 to 1	1,000,000 to 1

24 TIMES AS MUCH RECORDING TIME

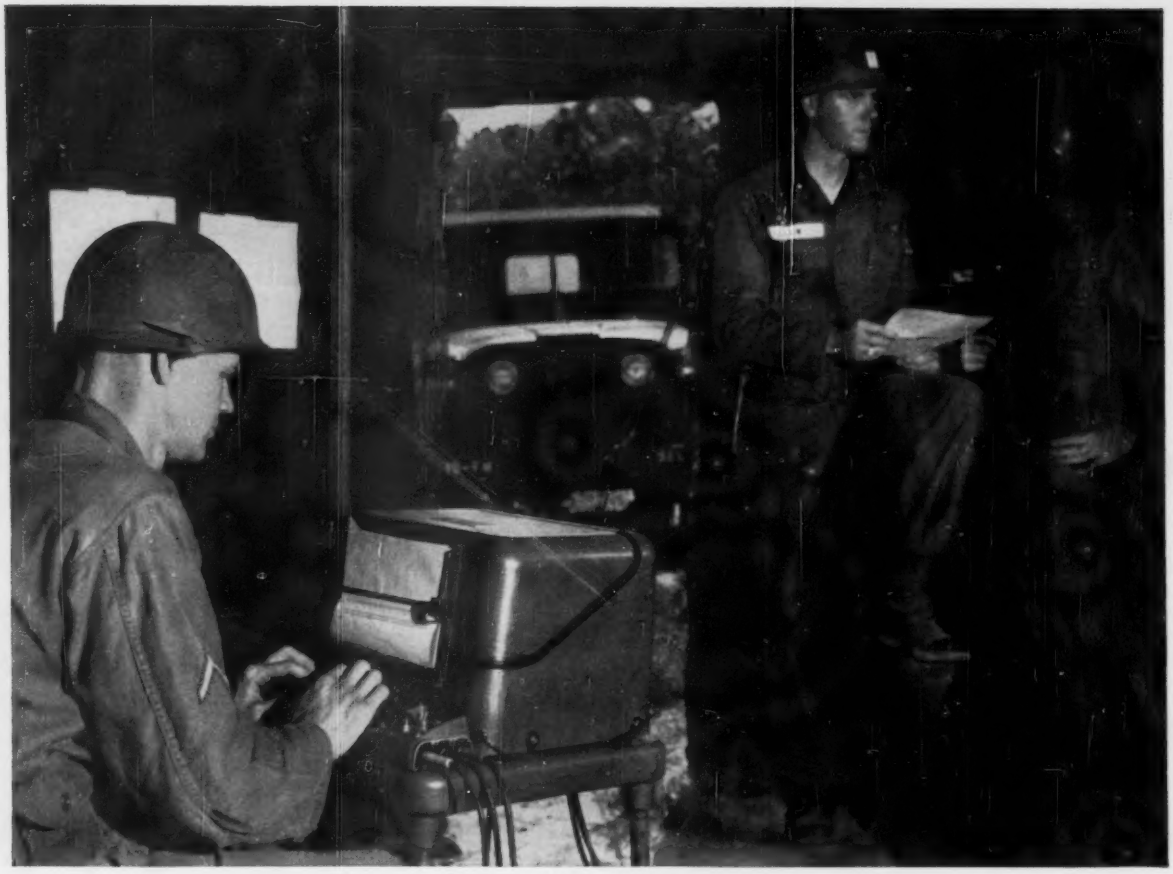
On 5000-cycle data, an ordinary 10½" reel of 1-mil magnetic tape will record 24 minutes. On a visual-trace recorder writing 100 cycles per inch, a 250-foot magazine of expensive paper would last just one minute! When you record data first on tape, you will seldom recopy the whole test onto paper. With an oscilloscope or other scanning device, you find the important parts of the tape and copy as little as a few seconds onto the visual medium. The tape can be stored for future reference, cut into loops for analysis or can be erased and reused. It saves hundreds of feet of paper.

Because magnetic-tape data is an "electrical analog", it can also be used for automatic frequency analysis, computer input, simulation of phenomena and scanning, counting and correlating techniques. We have told the whole magnetic-tape story in a well illustrated and diagrammed 16-page brochure. For your copy, write Dept. E13.

AMPEX INSTRUMENTATION DIVISION • 934 CHARTER STREET • REDWOOD CITY, CALIFORNIA

Phone your Ampex data specialist for personal attention to your recording needs. Offices serve U. S. A. and Canada. Engineering representatives cover the free world.

CIRCLE 35 READERS SERVICE CARD



Teleprinted Communications . . . on the double!

The Kleinschmidt teletypewriter set sends teleprinted messages from tape at speeds up to 100 words per minute.
AT THE SAME TIME, on the same unit, the operator perforates and prints other messages for transmission.

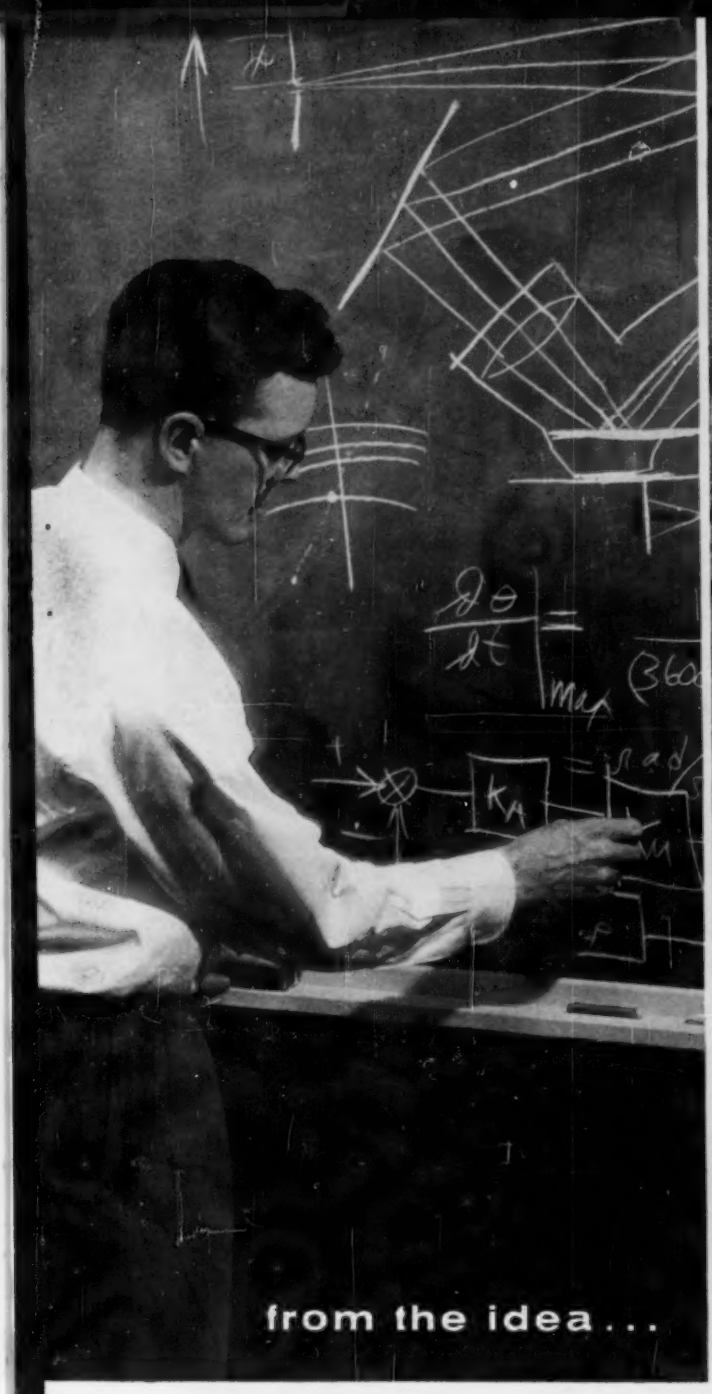
Day after day, Kleinschmidt teletypewriters and related equipment at U. S. Army Communication Centers receive and transmit thousands of teleprinted messages. This tremendous communications traffic, accelerated by multiple-function Kleinschmidt equipment, developed in cooperation with the U. S. Army Signal Corps, flows smoothly and precisely. Both sender and recipient receive a teleprinted original, identical in every respect.

Since the century began, the Kleinschmidt name has been associated with every major development in teleprinted communications. Now a member of the Smith-Corona family, Kleinschmidt looks ahead to new attainments in broadening the field of electronic communications for business and industry.

KLEINSCHMIDT

KLEINSCHMIDT LABORATORIES, INC., DEERFIELD, ILLINOIS

Pioneer in teleprinted communications equipment • A subsidiary of Smith-Corona Inc



...and everywhere in between – we'll serve you well

We have the experience and resources to take an idea—yours, ours or a combination of both—and to build that idea into a complete weapons, guidance and control, or inertial system. Bridging this gap effectively and within budget and time limitations is our business—has been for 18 years. Perhaps we have the very research, engineering and manufacturing talents you're looking for. We'd like to tell you more about them—and about how the military and industry use them in projects which require creative thinking and painstaking accuracy.

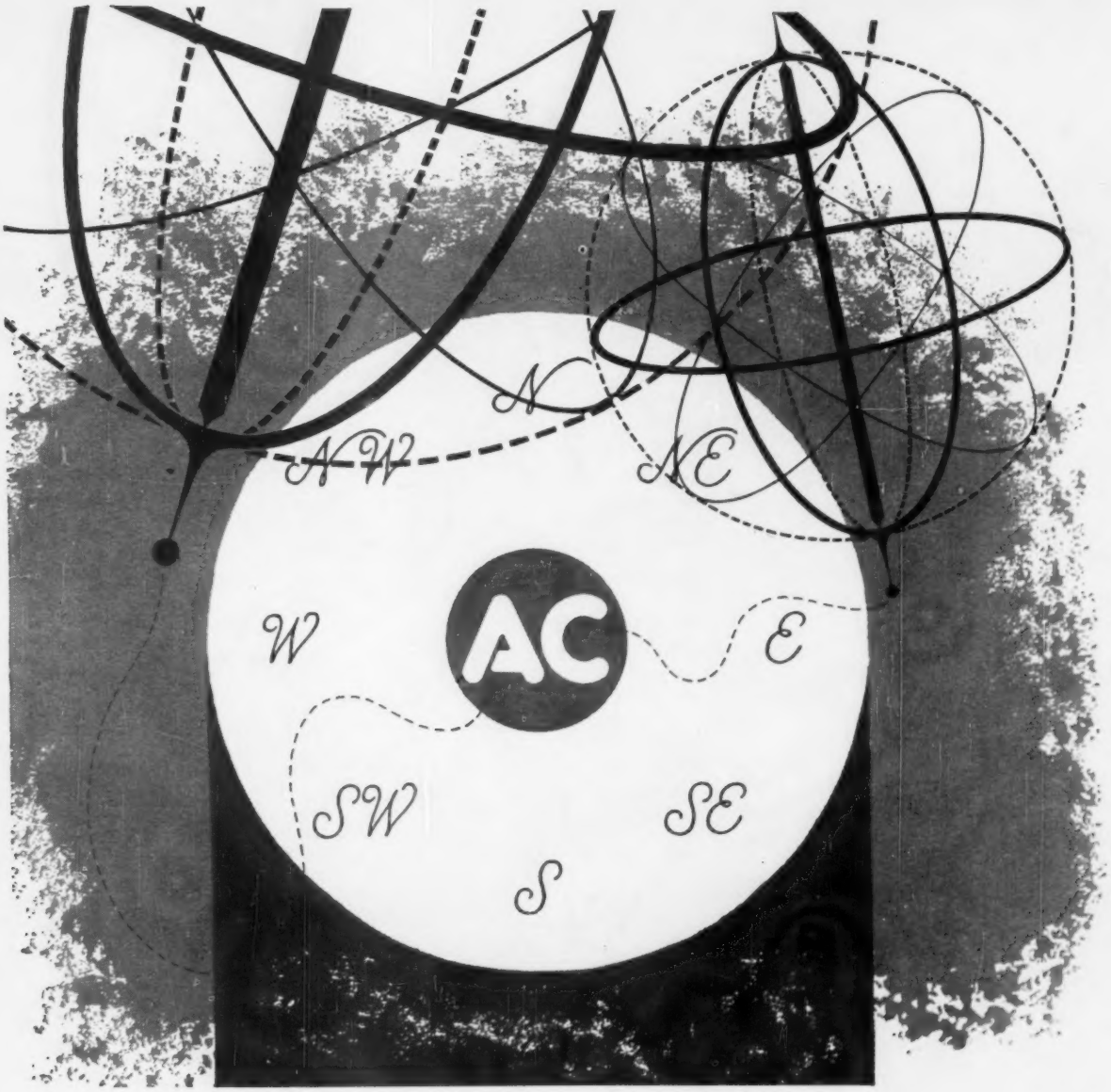
WRITE: MECHANICAL DIVISION of GENERAL MILLS
Dept. EL-5, 1620 Central Ave. N. E.
Minneapolis 13, Minnesota

CIRCLE 37 READERS SERVICE CARD

MECHANICAL DIVISION

Intelligent Engineering and Precision Manufacturing

General Mills



AC —new direction for gyro engineers

Now you can aim your career in a new direction . . . with a long-range future. For AC offers experienced gyroscope engineers the opportunity to work in design and development of gyros for some of the most advanced and far-reaching projects in America's defense and industry.

At AC you can work on floated gyroscopes for inertial guidance systems . . . inertial navigation systems . . . combination navigation and automatic pilot systems. You can grow with a company that's already a leader in the production of highest quality gyroscopes and other electromechanical devices.

This is worth thinking about: an AC future in which you can apply your talents to the fullest . . . on long-range projects of great importance . . . in an atmosphere of personal security and progress.

If you are a graduate engineer with three to six years' experience in floated gyroscope design and development . . . or in the field of precision instruments . . . you should talk with the people at AC-Milwaukee. Just write Mr. Cecil Sundeen, Supervisor of Technical Employment, Dept. A, 1925 E. Kenilworth Place, Milwaukee 1, Wisconsin.

AC SPARK PLUG ❀ THE ELECTRONICS DIVISION OF GENERAL MOTORS

Producers of: AChiever Inertial Guidance Systems • Afterburner Fuel Controls • Bombing Navigational Computers Gun-Bomb-Rocket Sights • Gyro-Accelerometers • Gyroscopes • Speed Sensitive Switches • Speed Sensors • Torquemeters

NEW OHMITE®

12½ WATT MINIATURE RHEOSTAT

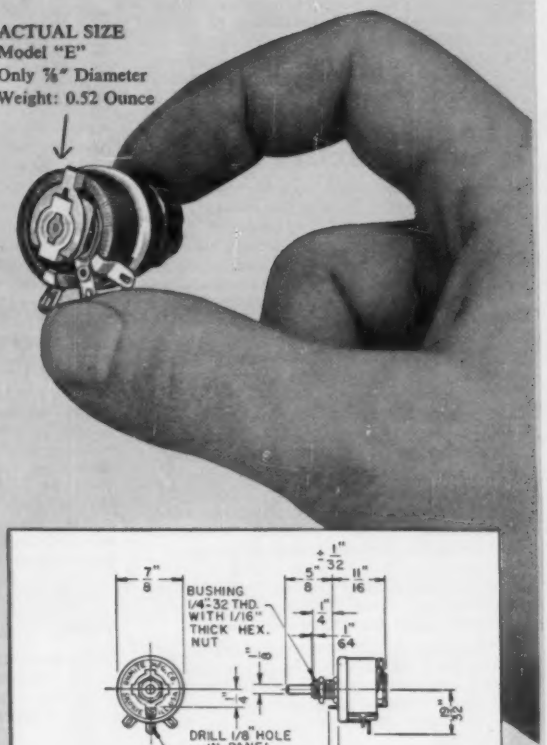
High power handling capability for small size

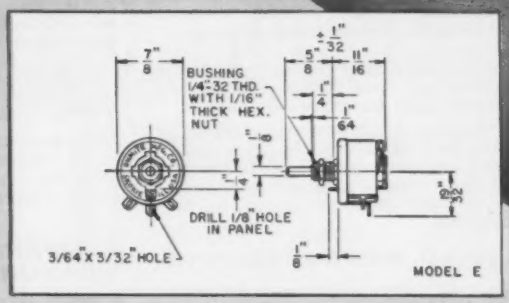
Newest addition to the Ohmite line of vitreous-enameled rheostats is the new Model "E" miniature 12½-watt rheostat. This new unit is smaller than many one- or two-watt potentiometers. It provides time-tested Ohmite all-ceramic and metal design features for uses where as much as 12½-watt dissipation is required and space is extremely limited. Built to operate at a maximum hot spot temperature rise of 300° C at an ambient of 40° C, Model "E" is also useful for operation at high military ambients, derated linearly to zero at 340° C, attained. Rugged, lasting, power rheostat performance is thus available in such small size that new possibilities in miniaturization and dependability are afforded the apparatus designer.

Like the larger Ohmite rheostats, Model "E" has a ceramic base, and ring-shaped ceramic core. Vitreous enamel holds the turns of wire against shifting, and fastens the base and core together. Also, the Model "E" has a ceramic hub insulating the shaft; a metal-graphite contact; folded spring arm; independent compression spring; slip-ring; a stop directly connected to the shaft. The entire assembly is a miniaturized, dependable version of the time-proven Ohmite power rheostat design. Mounting is by a ¼"—32 threaded bushing. The shaft is ⅛" in diameter. Resistance range: up to 5,000 ohms with 23 stock values; higher values available with OHMICONE inorganic coating. Resistance tolerance: ±10%. Torque: 0.1 to 0.2 pound-inch. A small finger-grip knob, in keeping with the rheostat dimensions, is available.

Special length shafts and bushings, screwdriver shafts, locking type bushing, tandem mountings, enclosures, etc., similar to the variations available on the larger rheostat, can be provided upon specific request.

ACTUAL SIZE
Model "E"
Only ⅞" Diameter
Weight: 0.52 Ounce





INDUSTRY'S MOST COMPLETE LINE OF RHEOSTATS

Now 11 Sizes! — 12½ to 1000 Watts

All sizes available from stock in a wide range of resistance values, including the NEW Model "E." Ten sizes are available to meet MIL-R-22A requirements in *each* of the 26 type designations.

RHEOSTATS RESISTORS RELAYS
TAP SWITCHES TANTALUM CAPACITORS
R. F. CHOKES VARIABLE TRANSFORMERS

OHMITE® QUALITY Components

WRITE FOR BULLETIN 157

OHMITE MANUFACTURING COMPANY 3610 Howard Street, Skokie, Illinois

How Magnets Help Solve Your Measurement Problems

This is a review of how magnets, magnetic devices and magnetic phenomena can be used to solve certain measurement problems, to improve production efficiency and to cut manufacturing costs.

Highly accurate and efficient measurement is an essential part of modern manufacturing. Today's mass production techniques require speedy analysis of conditions and dimensions of parts and materials. Literally hundreds of measurement problems are being solved effectively with instruments and devices that employ magnets.

ELECTRICAL MEASUREMENTS

Most common of the uses of magnets in measurement is in electricity—in such devices as ammeters, voltmeters, voltage protectors, KVA meters, power factor meters, arc-back indicators, limit and flow switches, frequency meters, galvanometers and oscillographs. In the ammeter there is either a stationary coil and a magnet that rotates when a current is passed through the coil, or a stationary magnet and a moving coil. The voltmeter is similar, with a high resistance in series with the coil.

Also similar is the galvanometer, but it is much more delicate and sensitive. An oscillograph is a special form of moving-coil galvanometer. Potentiometers, which measure small electromotive forces, consist of a circuit of resistances and a galvanometer. Frequency meters depend on the effect of the currents in two shunt circuits on a moving coil. One circuit contains inductance and the other capacitance.

Magnets in galvanometers and oscillographs combine with electromagnetic waves and electrons to provide integrated and recorded measurements, often remote from the locations of the measurements.

LINEAR MEASUREMENTS

Even the most simple linear measurements are assisted by magnets — by magnetic bases on height gauges, indicators, dials, roundness gauges, carpenter levels and magnetic plumb-bob. The thickness of a non-magnetic coating on iron can be determined by measuring the gap between the magnet in a tester and the iron object.

Radar sends out a high-frequency electromagnetic wave which is reflected back from the target to a receiving antenna. Speed of the wave is known, so that distance can be determined by measuring the time between emission and reception of the wave. The heart of this instrument is the magnetron vacuum tube, which depends on a high-intensity, uniform, permanent magnet field. Sonar is similar to radar except that its energy is in ultrasonic waves of 10 to 40 kilocycles.

Distance is also measured by proximity fuses and switches. The fuse depends on a permanent magnet generator for energy. It sends out a signal which is reflected by the target to actuate a firing mechanism; thus, a direct hit is not necessary. In the switch, a magnet is attracted to any iron or steel that comes near, closing the switch.

Direction can be measured by the aircraft direction indicator, the compass and the remote-reading compass transmitter. All these devices depend on magnets.

AREA MEASUREMENTS

Applications of magnets in land measure are numerous. We have magnetic maps, charts and markers, and vast areas are surveyed and measured by radar and sonar.

In the future it is likely that television, which uses magnets for focusing, ion traps and loudspeakers, will be used to measure areas.

VOLUME MEASUREMENTS

Liquid-level indicators and float switches often transmit the motion of a float to the indicating mechanism by magnetic attraction. In flow meters, volume of liquids and gases may be measured through a seal by such devices as a permanent magnet rotor turning in a venturi, a rotor in a liquid cutting flux lines of a magnet, molten metal flowing through a pipe and cutting magnetic flux, a magnetic clutch between a float and a recording mechanism.

TIME MEASUREMENTS

Permanent magnets are contributing much toward accuracy and ruggedness in actuators, clutches and brakes in clocks, timers, timing motors and traffic signals.

TEMPERATURE MEASUREMENTS

Magnets are used extensively in pyrometers, which are thermocouples connected to galvanometers calibrated in degrees. The optical thermometer employs a magnetic ammeter and in other thermometers magnets indicate the maximum or minimum temperature in a period. In many thermostats, magnets accelerate the contacts to increase accuracy and life.

SPEED MEASUREMENTS

Two of our best known modern instruments are the speedometer, based on eddy currents generated by a rotating magnet, and the tachometer, which is simply a permanent magnet generator. Magnetic couplings are used to connect tachometers to such machines as high-pressure turbines and other sealed equipment.

NEW MEASUREMENT INSTRUMENTS

There are possibilities for the development of new measuring instruments, based upon the following magnetic phenomena:

1 Magnetostriction effects, such as the change in length and volume of a rod when magnetized; the bending of a magnetized rod; the twist in a rod in a magnetic field; the change in magnetic induction of a rod under stress in a magnetic field.

2 The production of characteristic sounds and vibrations of bodies in a magnetic field; changes in period and frequency of vibrating bodies in a magnetic field.

3 Changes in apparent resistance of conductors introduced into a magnetic leld.

4 Changes in thermal conductivity of metals when exposed to a magnetic field; changes in permeability of magnetic materials; changes in boiling points and specific heats of some substances in a magnetic field.

5 The plane of polarization of light can be rotated by a magnetic field; double refraction of light has been observed in several mediums subjected to a magnetic field; similar effects occur with electromagnetic waves.

6 Transformations that occur in pure metals and alloys are affected by magnetic fields.

The foregoing discussion is condensed from an article which appears in "Applied Magnetics," Vol. 2, No. 4. Write for your free copy. If you would like to explore any of the possibilities discussed in the article, Indiana's engineering staff will be glad to offer recommendations and consultation.

NEW CATALOG AVAILABLE

Send for your free copy of the new "Cast and Sintered Alnico Magnet Catalog No. 19," which describes and lists typical sizes and shapes of these two most popular types of magnetic materials for experimental use. Also shown are permanent and electro-magnetizers and demagnetizers. Address Dept. A-5. 69

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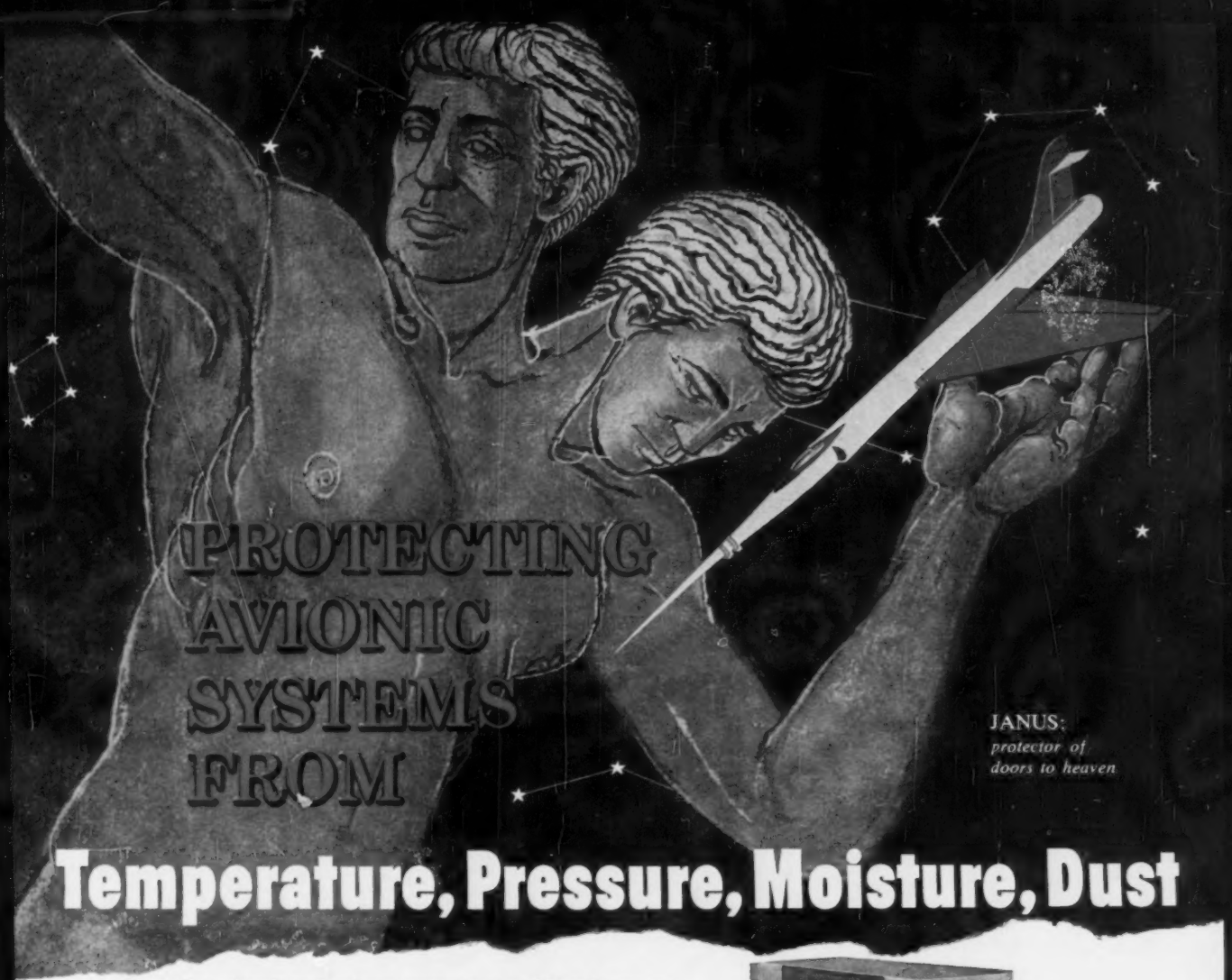

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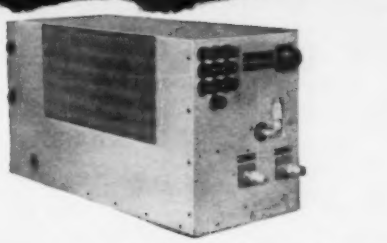

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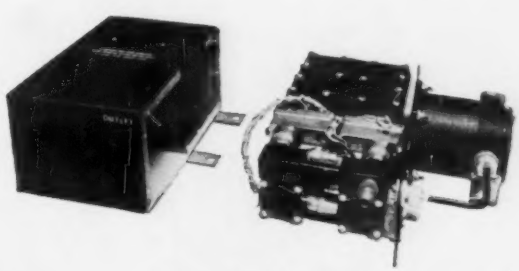

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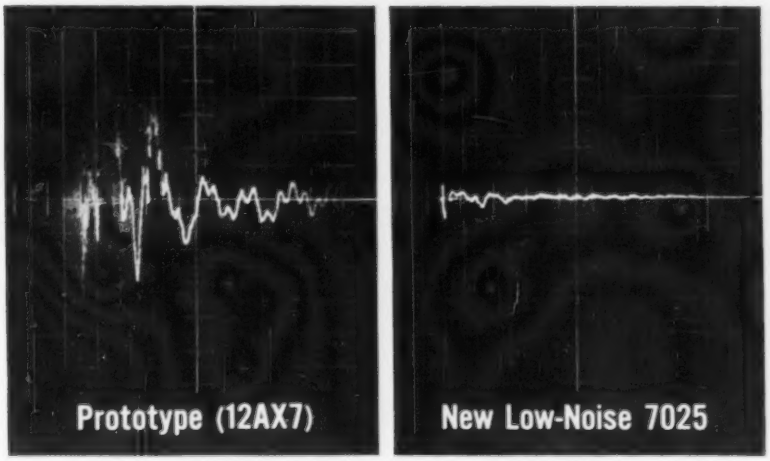
GENERAL ELECTRIC

TUBE DESIGN NEWS

FROM THE RECEIVING TUBE DEPARTMENT OF GENERAL ELECTRIC COMPANY

General Electric Low-Noise 7025 AF-Amplifier Tube Major Step Toward Improved Hi-Fi Reproduction!



Scope Trace at Right Shows Superiority of New 7025 Twin Triode

You can see by comparison the greatly reduced noise output of the new General Electric amplifier tube. A single, identical tap was applied externally to a 12AX7 and to a 7025, both representative tubes from current production. Vertical measurement is plate voltage . . . horizontal measurement is time. Conditions: E_b: 250 v, R_1: 10 K, E_c: −2.5 v.

Modern sound-reproduction techniques put a premium on low background noise. The richness of today's high-fidelity tone calls for circuitry and tubes that reduce hum, microphonics, and other noise to a level approaching silence.

General Electric, long a pioneer in audio research—originator of the famous variable-reluctance cartridge and other basic aids to sound reproduction—now assists circuit designers with an outstanding low-noise amplifier tube, the 7025. This new twin triode promotes hum-free, noise-free reproduction of both disk and tape sound recordings.

In equipment now being designed or in production, the 7025 will directly replace Type 12AX7.

New Snubber Mica Holds Cathode Tight. Special Low-Hum Heater Employed.

The new 7025 features a spring snubber mica applied to the top of the cathode, which exerts a damping effect on any movement of the cathode caused by shock or vibration. This cuts microphonics substantially.

Also, a new tube heater of special design reduces hum by virtually eliminating heater magnetic influences on plate current and consequent hum in the plate circuit.

High-precision General Electric manufacture has been called on to achieve extremely close fits of all tube parts—a third, important factor in low-noise performance.

For best audio, apply the new General Electric 7025 AF-amplifier tube! Complete information about this low-noise twin triode is available from any G-E Receiving Tube office listed on the following page.

Military Equipment Builder Finds G-E 7077 Ceramic Triodes Have Mean Noise Figure Below 5 db!

Using a high-performance test circuit of advanced design, the research laboratory of a large manufacturer of military equipment has found that a sample lot of G-E 7077 RF-amplifier ceramic triodes show the mean noise figure of 4.6 db at 16 db gain. Tubes were operated at 500 megacycles.

The new 7077 is rated at 5.5 db noise at 14.5 db gain, 450 megacycles under power-matched conditions. Therefore, the test performance underscores the tube's suitability for military use, where low noise and high gain are vital.

Intended primarily for communications, radar, and navigation equipment, the new 7077 is a high-mu triode of planar construction. Altitude rating is 100,000 feet. It is economical in price, dependable, and rugged.

Ceramic construction gives the 7077 exceptional heat resistance. The tube is expected to be useful up to 300 C. It is designed for optimum mounting in grounded-grid UHF amplifier circuits. Size is extremely small —less than ½ inch long and wide.

Orders are being accepted now for delivery this year. See page that follows for average characteristics and typical-operation data.

Tear off and keep this sheet for reference. It contains useful tube-application data.

GENERAL ELECTRIC 7077 RF-AMPLIFIER CERAMIC TRIODE

AVERAGE CHARACTERISTICS

Plate Supply Voltage	250	Volts
Resistor in plate circuit (by-passed)	18000	Ohms
Cathode-Bias Resistor	82	Ohms
Amplification Factor	80	
Plate Resistance, approximate	8900	Ohms
Transconductance	9000	Micromhos
Plate Current	6.4	Milliamperes
Grid Voltage, approximate $G_m = 50$ Micromhos	−5	Volts

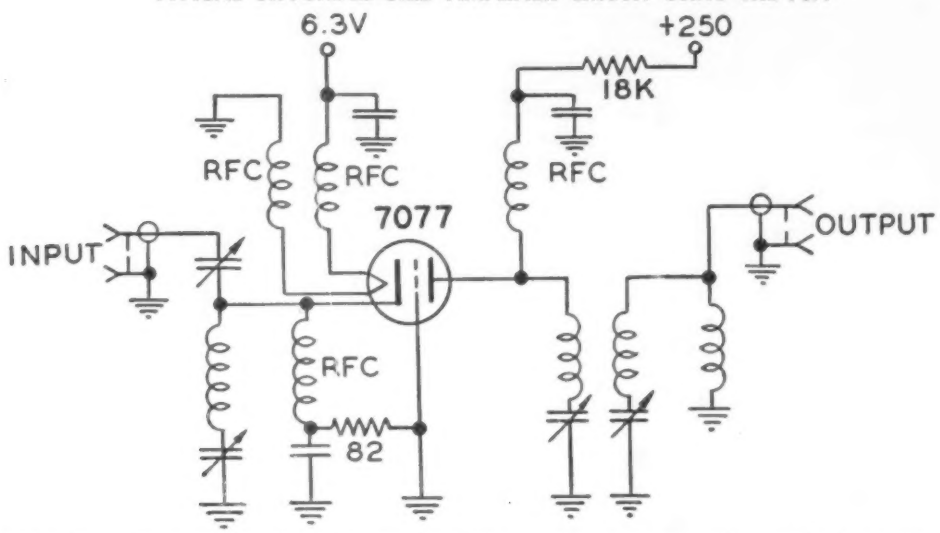
TYPICAL OPERATION

GROUNDED-GRID AMPLIFIER—450 MEGACYCLES

Plate Supply Voltage‡	250	Volts
Resistor in plate circuit (by-passed)‡	18000	Ohms
Cathode-Bias Resistor	82	Ohms
Plate Current	6.4	Milliamperes
Bandwidth, approximate	7	Megacycles
Power Gain, approximate	14.5	Decibels
Noise Figure (Measured with power-matched input, using argon lamp noise source), approximate	5.5	Decibels

‡ Lower supply voltage and a lower value of resistor may be used in the plate circuit with some sacrifice in uniformity of performance.

TYPICAL GROUNDED-GRID AMPLIFIER CIRCUIT USING THE 7077



Disclosure of the foregoing examples of the tube applications does not convey to purchasers of tubes any patent license, nor is it to be construed as recommending the use of such tubes in the infringement of patent claims.

For further information, phone nearest office of the G-E Receiving Tube Department below:

EASTERN REGION
200 Main Avenue, Clifton, New Jersey
Phones: (Clifton) GRegory 3-6387
(N.Y.C.) Wisconsin 7-4065, 6, 7, 8

CENTRAL REGION
3800 North Milwaukee Avenue
Chicago 41, Illinois
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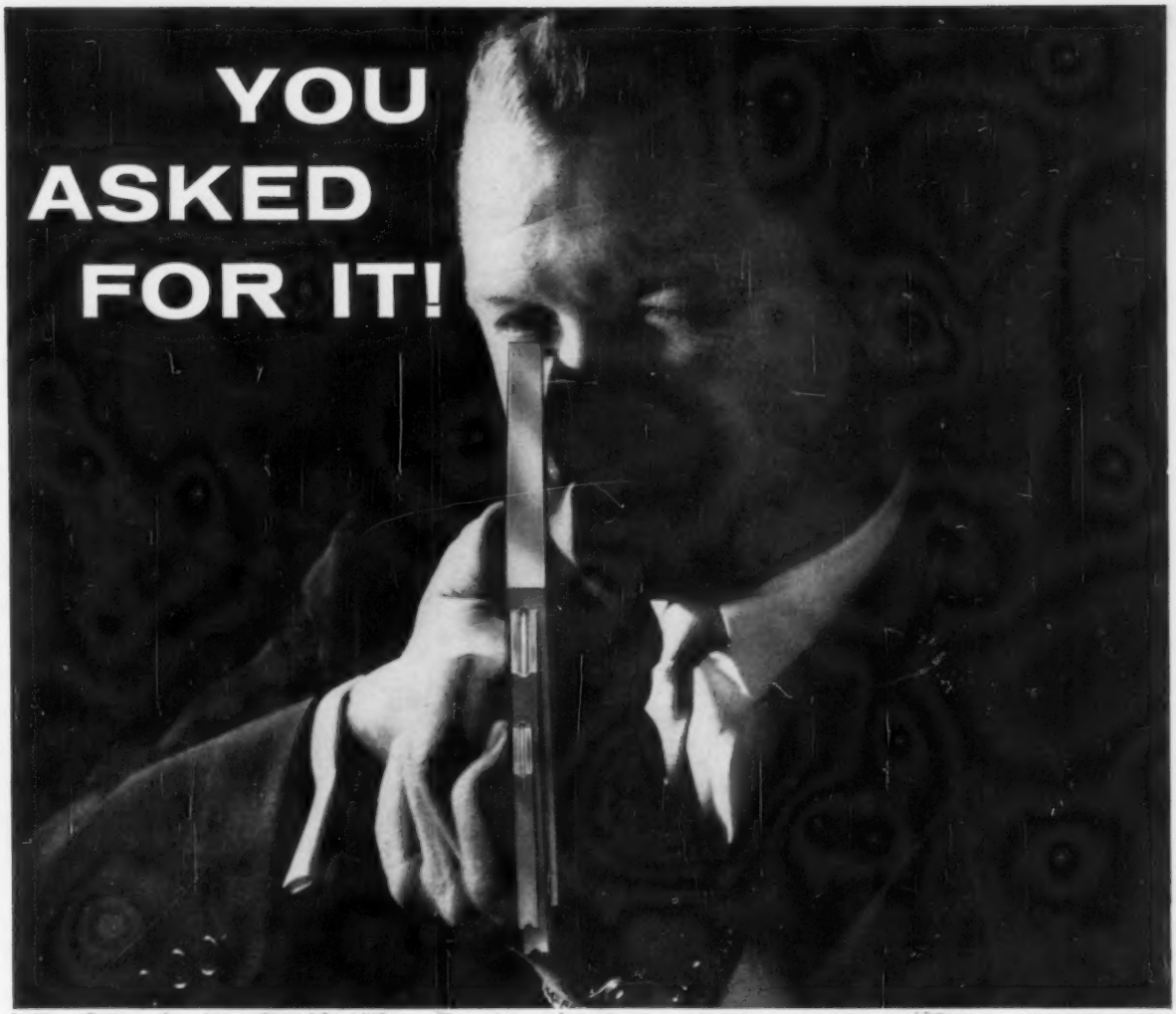
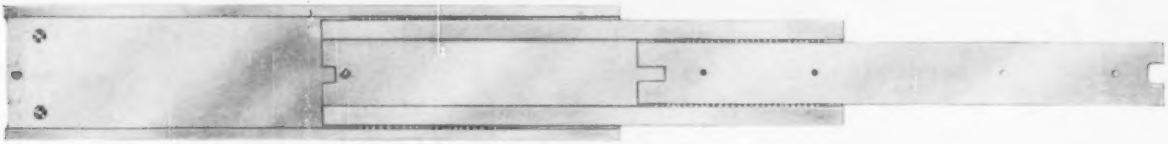


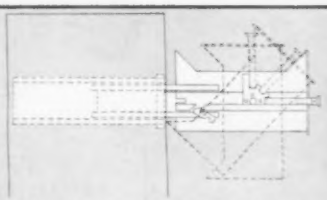
GRANT'S MARK II THINSLIDE



Yes, you asked for it. Design engineers throughout the nation asked for it . . . a continuous ball bearing action slide to fit standard cabinets, without cabinet modification!

THE MARK II THINSLIDE. Of extruded aluminum, only ½" in overall width . . . whose inner and intermediate members pass smoothly through the space between sliding unit and standard rack. With stainless steel balls, accurately fitted to members, the Mark II is quietly, quickly extended fully from rack . . . exposing all parts immediately and with almost no effort!

WRITE NOW FOR COMPLETE DATA ON THE MARK II THINSLIDE . . . the slide that you've been waiting for!



The MARK II offers tilt and locking devices as well . . . your unit can be pivoted to plus 45 and 90 degree positions for greatest accessibility. And you'll be amazed at the moderate cost of the Mark II . . . how quickly it will pay for itself **by allowing your equipment to be serviced and maintained in jig-time instead of down-time!**

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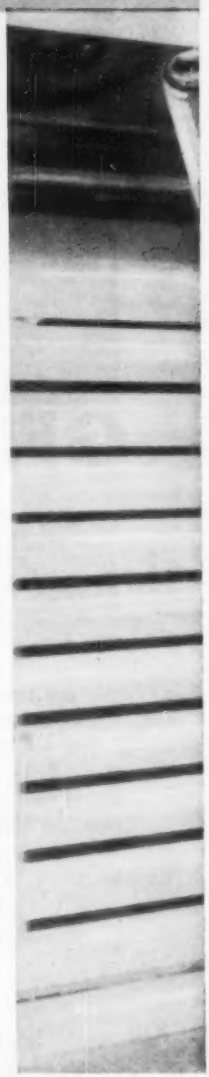

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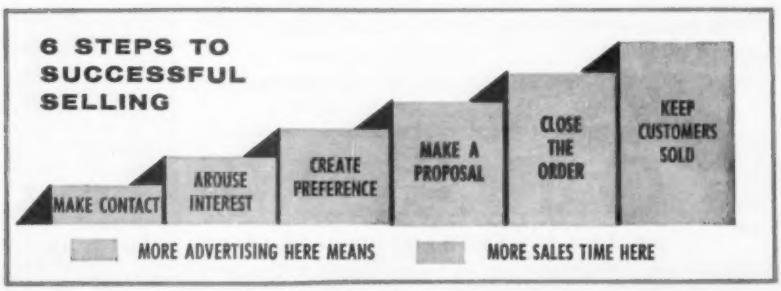

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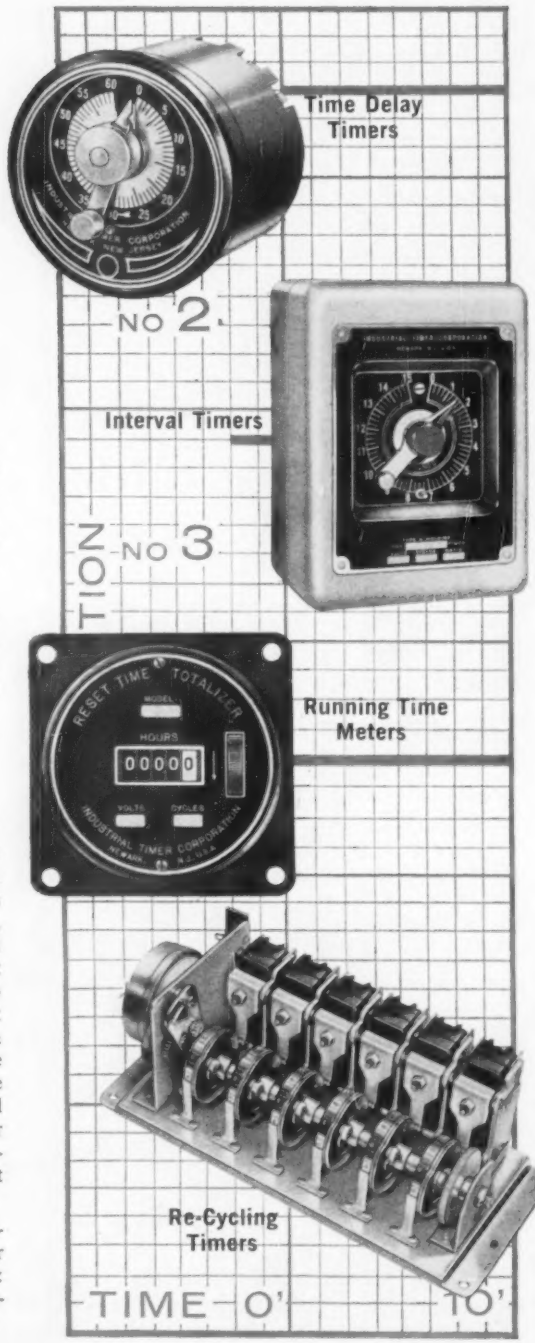

Speed up your automatic control projects— profit by our timing application experience

Sometimes you need a standard model timer . . . other times you need a special. Either way we can give you the extra rapid service you may need because of the efficient way we design, manufacture and stock timers for industrial applications.

To meet *all* of the widely varying needs of our customers we manufacture a complete line of timers in the four broad classifications illustrated here:

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From these we have already developed 20 basic types which can be combined in endless number of ways . . . to date, our engineers have combined them into over 1000 different models. So what might seem to be a special timer requirement to you, will very often be a standard timer in our large stock, and that is the reason we have the ability to fill special orders so quickly. And as far as standard timers are concerned we can give overnight service if necessary.

So, for the utmost in all-round service depend on us for this outstanding combination: deliveries "Immediate on Standards . . . First on Specials".

No need to let timing problems delay you in your automatic control projects when you can place them with us and get faster solutions. Even though no two automatic control jobs are ever exactly alike, and even though the timer requirements of each are very different we have established an excellent record in helping out in these situations.

20 years of experience in analyzing complex timer applications has provided us with the special knowledge required to give our customers the right answer in near-record time.

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Extra special automatic control timer — this calls for original designing. Our engineers will go right to work and get the job done. That's the way we grow and we like it.

Whatever your control problem, you have everything to gain by submitting it to our timer specialists. They'll come up with the answer — almost with the speed of automatic control itself.

AFFILIATE—LINE ELECTRIC COMPANY

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INDUSTRIAL TIMER CORPORATION

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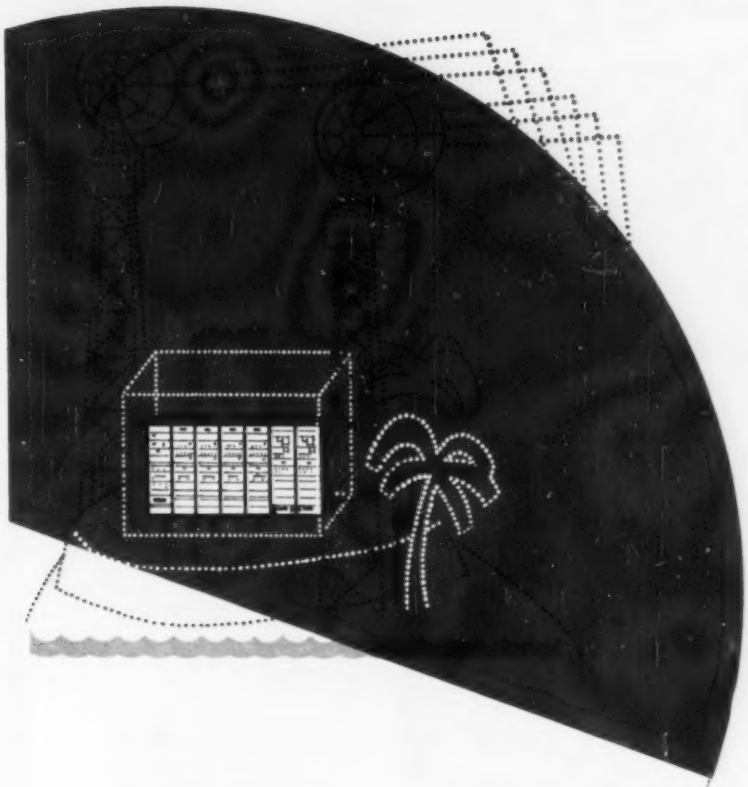

MID-PACIFIC TROPO

A new link in America's communications for defense is the Pacific radio circuit under construction for the U. S. Army Signal Corps.

One type of propagation utilized for this important system will be tropo scatter. The choice was quite naturally REL radio equipment—driver exciters, klystron amplifiers, and diversity combiner receivers.

REL's acknowledged world leadership in tropo scatter reflects the unequalled performance and reliability of REL equipment. More kilowatt miles of tropo apparatus have been developed and manufactured by REL than by all other companies *combined*.

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Diode Manufacturer uses Electro Instruments X-Y Recorders to plot Zener diode characteristics

INCLUDES PLOT WITH EACH DIODE

International Rectifier Corporation, manufacturers of Zener diodes, plots the reverse breakdown characteristics of each diode. These plots accompany the diode to the customer and provide an immediately useful graphic description of the individual unit's transfer characteristics. As shown below, the plots are made with an Electro Instruments Model 100 X-Y Recorder.

These proven recorders fulfill the most demanding operational and performance requirements. They possess such advanced design features as transformer-isolated servo-controlled cable drives to eliminate backlash, an internal vacuum hold-down and carriage slewing mechanism for easy paper insertion, and a positive paper indexing provision for measurement repeatability. Operating controls are kept to a minimum and are logically grouped for maximum operator convenience.

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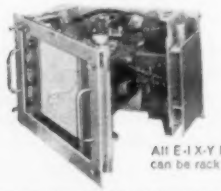
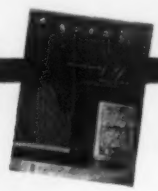
The Model 200 (Computer Output), the Model 215 (Potentiometric Input), Model 225 (General Purpose Plotter) are larger (11" x 17") machines. The basic precision recording capability of these machines is readily expanded to cover more complex input/output data reduction tasks. For this purpose E-I offers a series of auxiliary equipments—Integral Curve Follower, Model 275 Medium Speed Digital to Analog Converter, the Model 250-A Symbol Generator and the Model 260 Time Base Generator.



All E-I X-Y Recorders can be rack mounted

Model 100 Specifications

Axes: Independent X and Y isolated axes.
Accuracy: ±0.2% full scale.
Scales: 16 ranges, both axes, from 0.5 mv/inch to 50 volts/inch, mv/inch: 0.5, 1, 2.5, 10, 25, 50, 100, 250 and 500; volts/inch: 1, 2.5, 5, 10, 25 and 50.
Input Resistance: 0.5 mv/inch, essentially infinite at balance with low resistance source: 1.0 mv thru 500 mv/inch, 200 kilohm/volt; 1.0 volt thru 50 volts/inch, 2 megohms.
Zero: Full scale zero control with one full-scale length zero offset provided by 10-turn pots.
References: Internal mercury battery.
Paper Size: 8-1/2" x 11".
Slewing Speed: Pen 13" sec.; carriage 19" sec.
Power Input: 115v ±10v, 60 cps., 60 watts standby; 125 watts operating.
Dimensions: 10" (max.) high x 12-3/8" wide x 18" deep.



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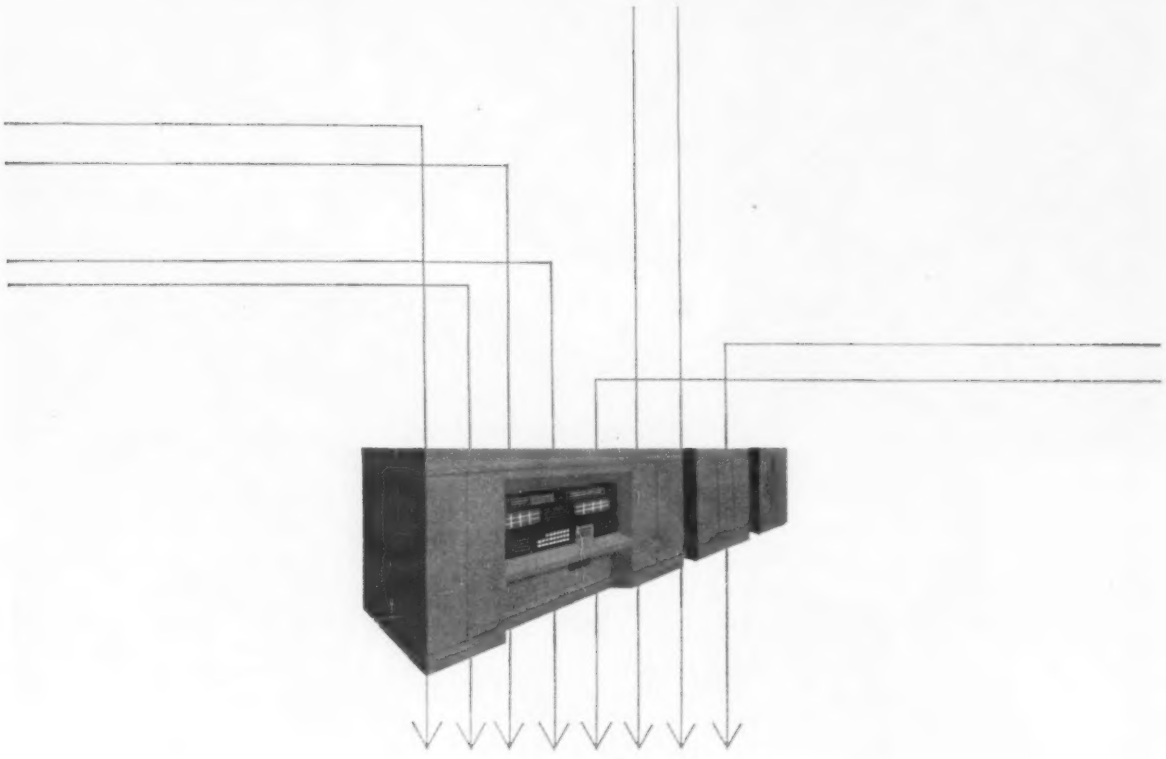

The **ORGANIZATION** and **RETRIEVAL** of **INFORMATION**

The organization and retrieval of large volumes of diverse types of information is rapidly becoming one of today's more serious problems. Major areas where the problem exists include business and industry, the military, the government, and the scientific and engineering community itself.

In its simpler forms, the problem may involve, for example, the automatic handling and analysis of business data such as payrolls, sales and manufacturing figures, insurance premiums, and other essentially statistical data. At the other extreme are certain complex military situations which require the concurrent interpretation, analysis, and integration on a very short time scale of data from a wide variety of sources, including field reports, photographs, news reports, estimates of industrial activity, and the like. In many of these situations, there is the additional requirement to translate the information from a foreign language into English.

The development in recent years of electronic data handling equipment is now making possible the practical solution of many of these problems. Such equipment has the capability to perform arithmetic operations, make decisions among alternatives, store and retrieve large quantities of information, and at high speed automatically perform long, complex sequences of operations.

At Ramo-Wooldridge, work is in progress on advanced information handling systems that are characterized by large volume and widely different forms of information, short time scales, and a variety of uses and users. The scope of the work includes the planning of systems and procedures, programming various types of data handling equipment, and formulation of requirements for new equipment. Research is also under way on the machine translation of foreign languages into English.

Engineers and scientists with experience in the following fields are invited to explore the wide range of openings now available:

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EDP Systems
Computer Programming
Console Design
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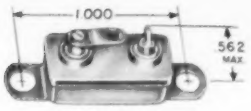
Fenwal's New Hermetically Sealed Miniature THERMOSWITCH® Unit

VERY SMALL • **HIGHLY SENSITIVE** • **EXTREMELY RUGGED**

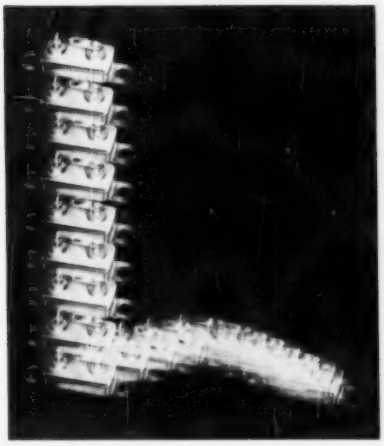


VERY SMALL

— *three* units are as small as a common sugar cube. Light, too — weighs less than 1/3 oz.!

HIGHLY SENSITIVE

— it has an inherent sensitivity of less than 1°F. And its thin wall case has low thermal mass — to give extremely fast response to temperature variations.



EXTREMELY RUGGED

— when vibrated per MIL-E-5272A, Procedure 1, there are no resonant frequencies between 5 and 500 cps. Even when tested at 500 cps with 10G acceleration it maintains normal control characteristics!

TYPICAL APPLICATIONS

- Crystal and transistor ovens
- Missile batteries
- Computers
- Electronic instruments
- Small industrial machinery
- Medical and dental equipment
- Airborne instrumentation

Fenwal

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HERE'S THE REST OF THE STORY—

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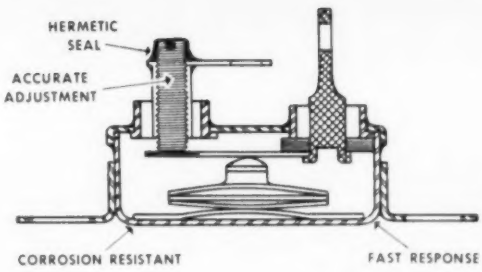
Hermetically sealed, yet field adjustable. Soft solder sealing of the adjusting screw permits field adjustments without destroying the hermetic seal.

Accurate, easy field adjustment, due to fine pitch adjusting screw.

Corrosion Resistant — type 305 drawn stainless steel case.

Fast Response — thin wall case has low thermal mass and low time constant.

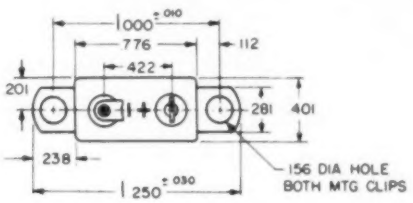


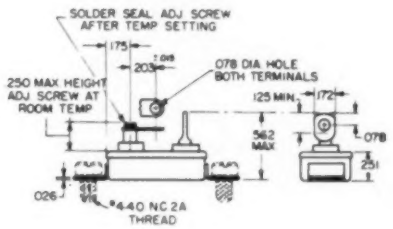
HERE'S HOW IT WORKS!

Differential expansion of metals — that's the operating principle of Fenwal's new Miniature THERMOSWITCH unit. Temperature changes expand or contract the stainless steel outer case. This activates the inner assembly, making or breaking the totally enclosed contacts. This means fast reaction time, since the heat sensing area is the *outer case itself* which always is in contact with the medium to be controlled.

HERE ARE THE PARTICULARS!

Fenwal Hermetically Sealed Rectangular THERMOSWITCH unit. Model 32400.





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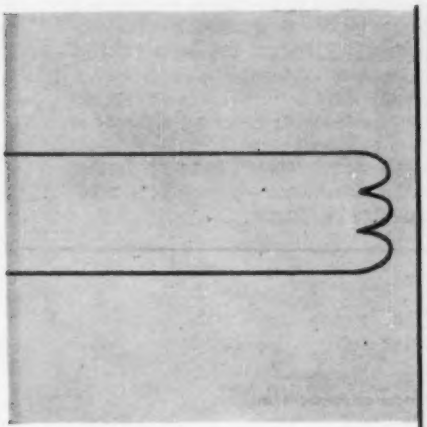

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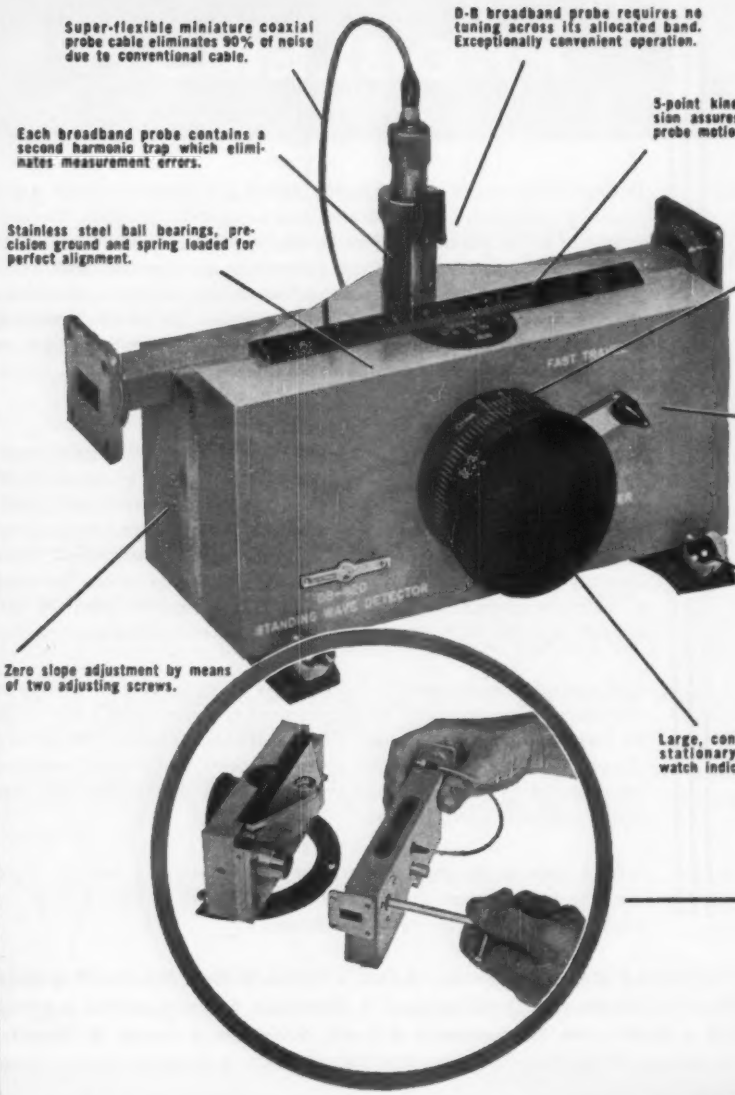
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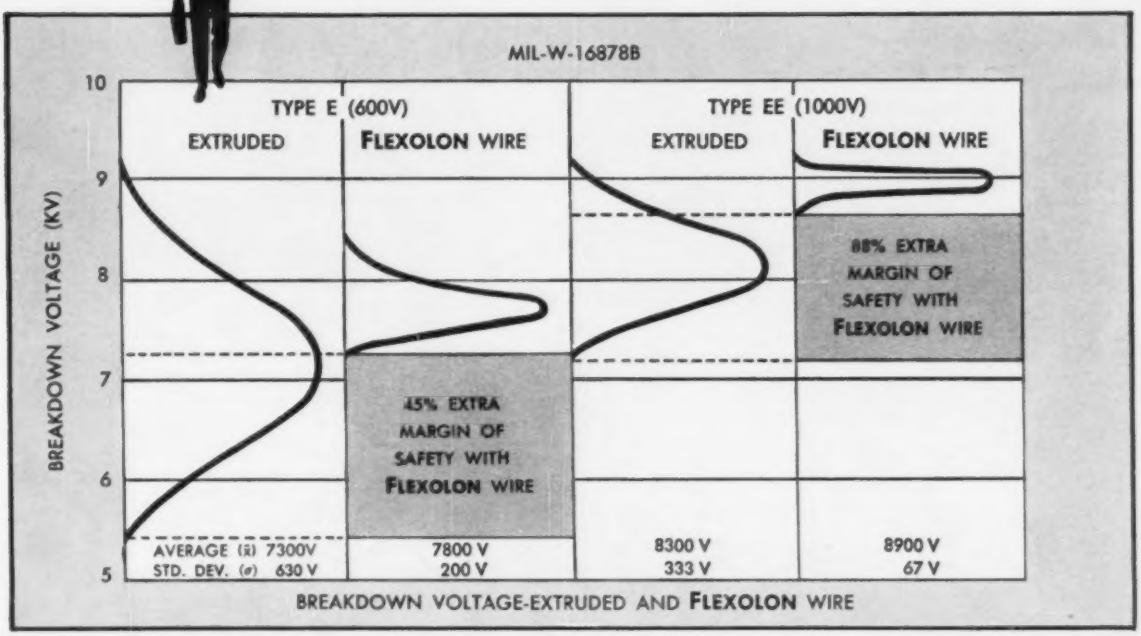

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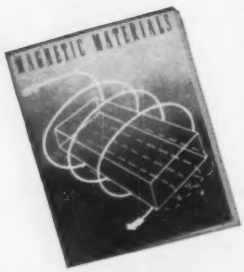

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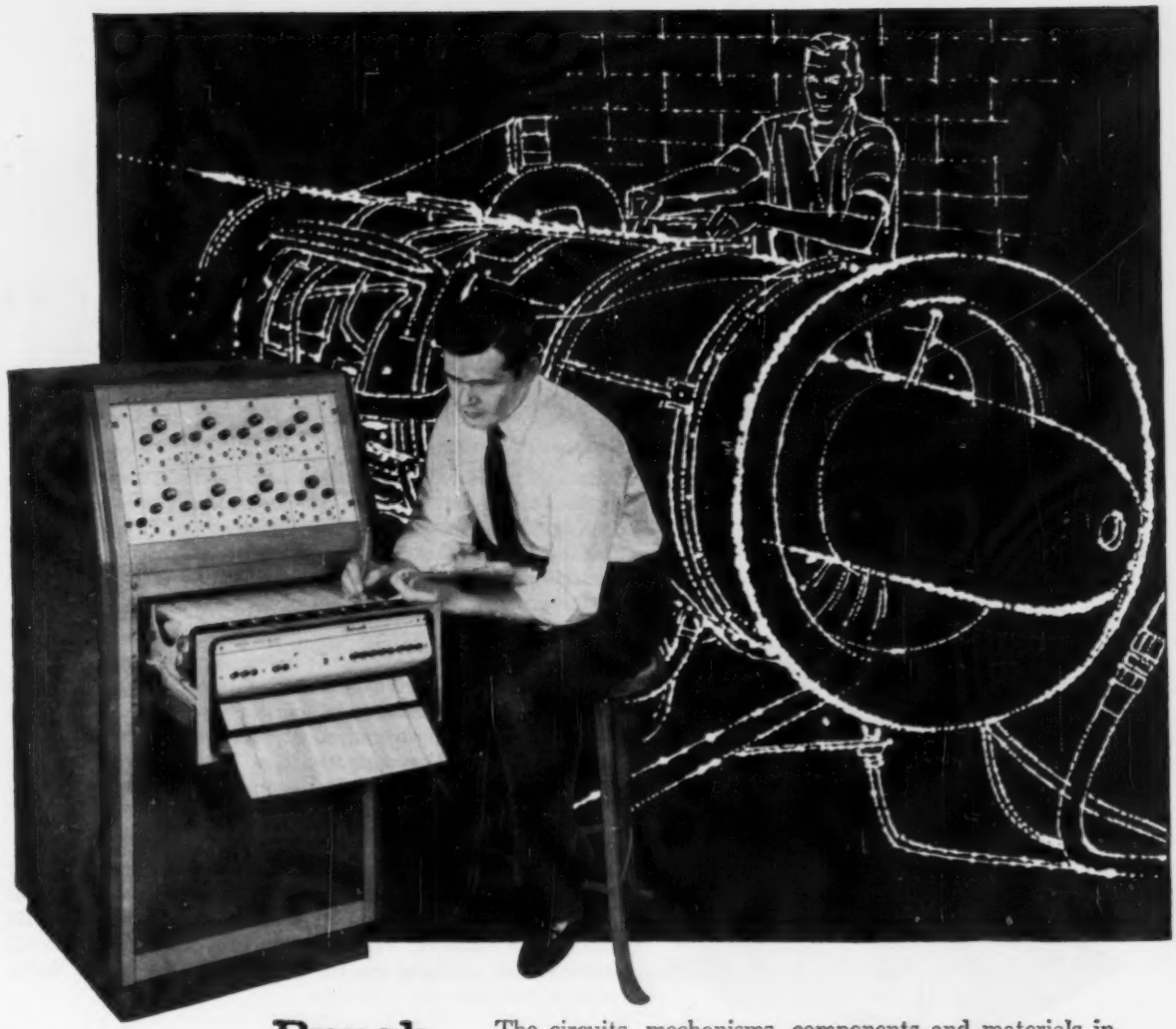

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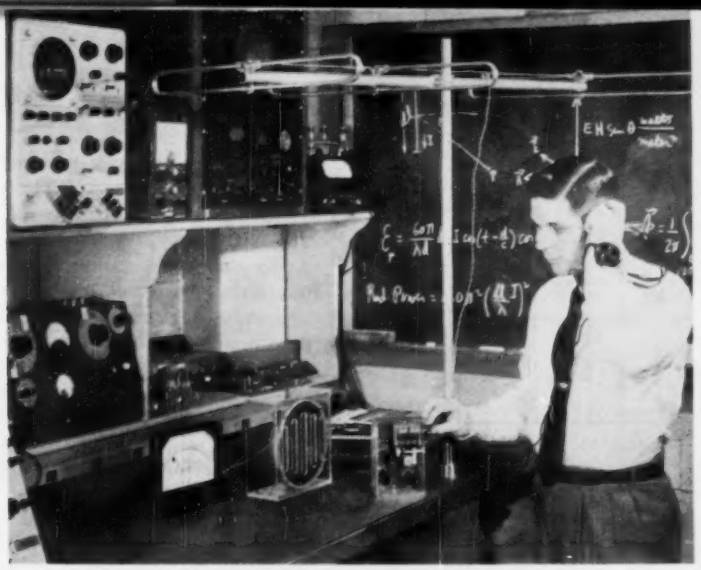


Author tunes information circuit of radiation powered transistor receiver. Operating voltage for information and audio amplifier circuits is provided solely by r-f energy extracted by and stored in power circuit

Radio Waves Power Transistor Circuits

Energy storage system supplies all power requirements for specially designed transistor circuits. Operation consists of receiving and rectifying r-f radiation, storing resultant d-c energy and releasing the energy as required to associated circuits. Unique dipole rectifier provides efficient antenna-to-receiver coupling for frequencies above 50 mc. Energy sources can be special purpose transmitters or commercial broadcasting stations

By L. R. CRUMP, Diamond Ordnance Fuze Laboratories, Washington, D. C.

RAPID ACCEPTANCE of transistors is largely the result of their low voltage and current requirements—a few microwatts being sufficient power for many applications. The system discussed here derives all power required to operate various types of transistor circuits from electromagnetic energy radiated by distant sources.

Although system details depend somewhat upon the intended application, certain design features are common to any application. These are: one or more circuits for the reception and storage of electromagnetic energy, a circuit for the detection and amplification of an information signal and a load to use the stored energy.

Power Circuit

A transistorized receiver using a radiant energy power circuit is shown in Fig. 1. All input signals are applied to information coupling coil L_1 and power coupling coil L_2 simultaneously; however, each circuit can be tuned to the same or different operating frequencies.

After being detected by a parallel resonant circuit consisting of coil L_2 and variable capacitor C_1, the incoming r-f signal is rectified by diode D_1 and the resultant d-c voltage applied to storage capacitor C_2. When charged, capacitor C_2 becomes the sole power supply for the receiver.

The storage capacitor should be of the high quality, low-leakage type. For maximum power absorption and use, the power circuit should be broadband tuned, tightly

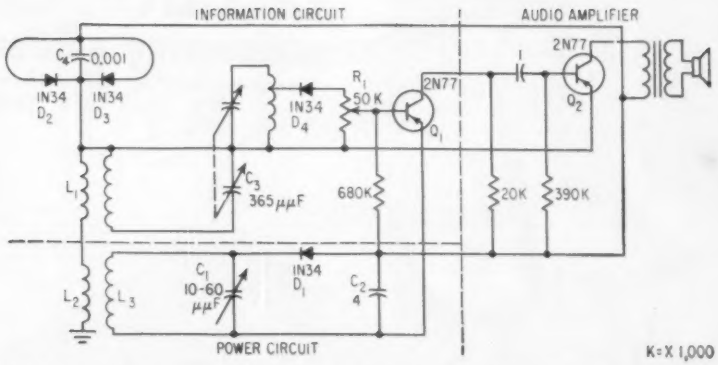


FIG. 1—Broadcast receiver. Specially constructed tuning coils are used but can be replaced by standard coils. Antenna and power circuits are designed to operate at all communications frequencies

coupled to the antenna and impedance matched to the load. Additional storage circuits, tuned to the same or different signal sources, may be used to obtain increased power at a common output.

Antenna Considerations

For signals below 50 mc, a conventional antenna 50 to 150 feet long, elevated as high as possible and positioned perpendicular to transmitter-receiver line of sight is recommended. A radiant energy power circuit fed by a 100-ft antenna which was 12 ft above the ground, in a suburban area and approximately 1½ miles from a 1 kw, 1,600 kc transmitter delivered 0.9 mw to a 9,000-ohm resistive load. The open circuit potential across the storage capacitor was five volts. A large loop antenna with one side facing the transmitter is also recommended.

For signal sources above 50 mc a resonant folded dipole rectifier system is used. Functionally, the antenna system operates like the center-tapped secondary winding of the transformer in a full wave rectifier circuit. This is done by connecting two output terminals of the dipole directly to the cathodes of individual diode rectifiers as shown in Fig. 1. The two anodes are tied together and coupled to the zero potential point at the back of the folded dipole through an r-f filter capacitor.

Since diodes D_2 and D_3 form a partially reactive load, the antenna is designed to resonate at the desired frequency with the rectifier circuit in place. Because the r-f potential across capacitor C_4 is essentially zero, unmatched lines may be used to draw d-c power without detuning the antenna. High rectification efficiency is necessary; therefore, the diodes should have a low capacitance, high back resistance and low forward resistance.

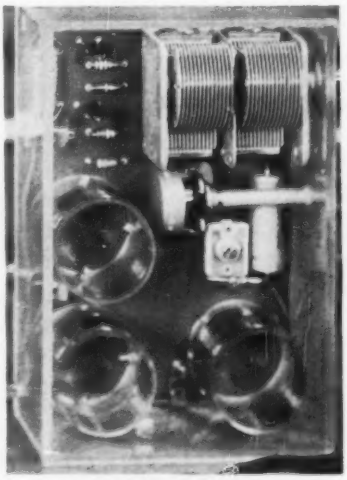
Several radiant energy power dipoles can be connected in series or parallel to increase d-c voltage or current as required. When such a multiple system operates at the same r-f signal frequency, the antennas must be properly spaced for maximum system gain. An experimental arrangement using three dipoles is shown in Fig. 2.

An array of three series-connected, three-unit dipoles feeding the same load delivered a total of 3 mw and charged a two microfarad capacitor to 54 volts. Since a lower voltage was desired for transistor circuits, the units were connected in series and parallel across the capacitor to obtain an 8-volt potential.

Information Circuit

Information receiving circuits shown in Fig. 1 can be tuned to the power signal frequency or to some other selected frequency. In either case the modulation of an incoming signal is detected by diode D_1 and fed into transistor amplifier Q_1. Basic information circuit requirements are high selectivity, low power drain on the capacitor with zero input signal and efficient energy transference to the load.

High-Q circuit elements should be used to provide high selectivity.



Dual-circuit receiver shown here converts radiations from strong local stations into power necessary to amplify signals from weaker or more distant stations. When both the information and power circuits are tuned to the same station, the signal is amplified by the power derived from the station's r-f carrier

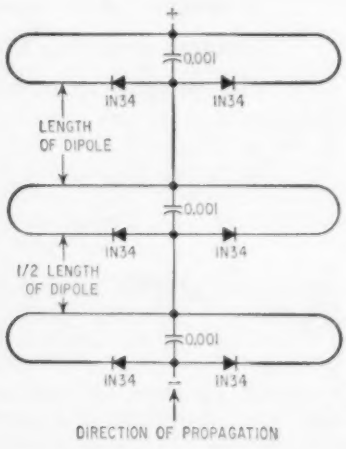


FIG. 2—Multiple dipole antenna. This combination delivered one milliwatt to a 2,500-ohm resistive load when tuned to a 189 mc, 50 kw transmitter located approximately one mile away. A similar array was capable of producing a total of 3 mw of power and charging a 2-μf capacitor to 54 v

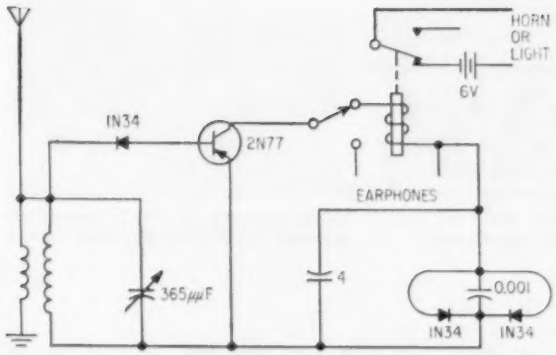


FIG. 3—Emergency receiver and alarm device. By pretuning information circuit to Conelrad's 640 or 1,240-kc emergency frequencies, civil defense broadcasts can be received regardless of availability of local power sources

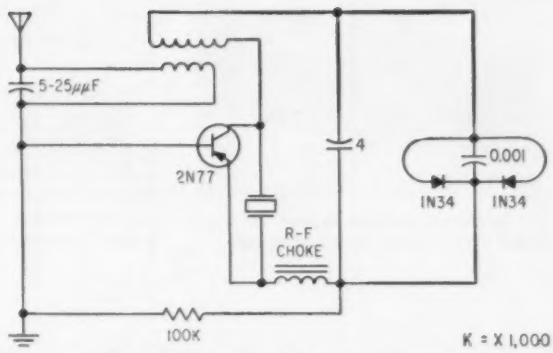


FIG. 4—Transponder. Power received at some specific frequency is used to energize the transistor oscillator at a different frequency thereby making it useful as a device for detecting position of aircraft or any other object capable of housing such a device

When the same antenna is used for both power and information signal reception, all signals should have similar magnitude at the amplifier input. To avoid saturation and distortion of the signal in a high-gain amplifier, the signal having the greatest field strength at the receiver is attenuated by absorbing most of the signal strength in the energy collecting circuit. Selectivity can also be increased by trapping strong signals occurring near the desired information frequency being transmitted.

In switching circuit applications, transistor Q_1 is biased for the lowest collector current which will operate the load device with a given signal input. A minimum leakage current is necessary for maximum efficiency of energy storage and use.

Large zero-bias collector current limits the capacitor charge and precludes use of low-current relays which are desirable in certain applications. To further conserve power, audio amplifier Q_2 should be operated class A at the minimum collector current.

Load Considerations

An unmodulated carrier, transmitted at the resonant frequency of the power signal receiving circuit, will continuously charge the storage capacitor. Remote switching of power is accomplished by triggering the transistor amplifier with a modulated power signal or with a modulated signal transmitted on a selected control frequency.

Amplifier output, in most applications, is connected to a current actuated device such as a relay, headphone or loudspeaker. When modulated transmission ceases, power output to the load also ceases.

Substitution of a transistor oscillator for the information signal circuit permits d-c to be converted into a-c of a selected frequency having high-voltage pulses. By applying the oscillator output to a step-up transformer, a higher voltage is developed which can be rectified and stored in a capacitor. A breakdown diode placed between the storage capacitor and the load could be used to dump the capacitor charge across the load when the required voltage level is reached.

Remote Switching

A large number of unpowered transistorized radio receivers, pretuned to selected frequencies for power and information, when distributed within range of a power radiating source could be simultaneously activated by turning on the transmitter. This arrangement could be useful in public address, alerting or civil defense alarm systems.

A circuit for an emergency receiver and alarm device is shown in Fig. 3. When a signal is received, the control switch applies power to an alarm. During the long standby time, no power is drawn from the battery source.

Signals other than modulated r-f can be used to trigger the switching device. For example, the output of a magnetic-type microphone energized by a car horn can be used to operate garage door controls.

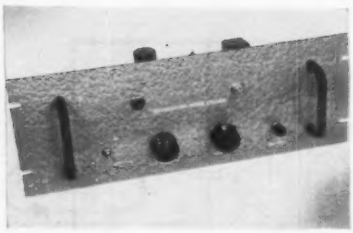
Transponder

Another application of the energy storage principle is in the transponder circuit shown in Fig. 4. This device can be used to identify and indicate the position of airplanes, harbor buoys, land markers and the like.

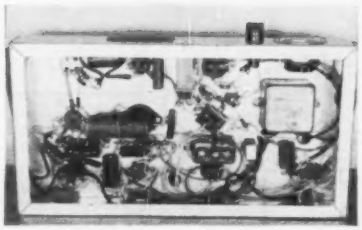
Addition of a microphone to modulate the output of the oscillator extends the applications to short range reception and transmission used in wireless intercommunications, public address and other systems. Also, the microphone could be energized at a remote location and used as a concealed listening device.

By using a small receiver fitted inside the ear in conjunction with a fixed-tuned vest pocket transmitter, the device could be used as a personal radio or hearing aid. Transmitter output could be modulated by a microphone for hearing aids and by a simple radio receiver for personal radios.

Many applications may occur to the reader within his own special field of interest. Further research, coupled with special-purpose component design will undoubtably extend present applications.



All functional controls appear on front panel except power switched in rack



Readily-available parts are used and wiring is conventional point-to-point

In-line mounting of plug-in components improves appearance, simplifies service

Squelch Circuit Mutes

By **DANIEL CRONIN** Chief Engineer, Bell Sound Studios, New York, N. Y.

MAGNETIC TAPES stored for some time often exhibit *print-through*, a magnetic signal induced onto layers adjacent to the original signal. The effect is a number of "echoes" before and after the true signal, usually around 50 db lower in level, but sometimes as little as 20 db down. The masking effect of any continuing sound such as orchestral music often makes the effect unnoticeable, but during soft passages it can be highly disconcerting.

Speech material is much more revealing of this defect, however, and poetry readings and language-instruction courses which leave pauses for the student to repeat the instructor's phrases are especially vulnerable. Some runs of tape are more prone to print-through than others, and high-temperature storage can easily increase the transfer level 10 or 15 db even on the better oxide formulations.

Called a background-noise eraser, a device which suppresses this print-through with a semiconductor diode circuit that rejects all signals below a certain threshold level has been developed and is described in this article.

Basic Squelch Circuit

The basis of the circuit is shown in Fig. 1. Each diode is back-biased by about 0.1 v. If program peaks are about 10 v the diodes will be non-conducting for all signals more than 40 db below this peak. When the input exceeds it the diodes will conduct, the upper diode on positive half cycles, and the lower one on negative swings.

The tiny slice of signal, near the zero axis, which is removed in this process leads to severe distortion, however. In Fig. 2 is shown the way around this problem. Signals higher than threshold are amplified, rectified and filtered, and used to keep the diodes in a conducting condition throughout each word. Time constants are chosen to make the distortion-removing voltage have a rise time of about 1 millisec and decay more slowly.

Theoretically the first millisec or so of each word is still distorted, but this is not noticed in practice. The ear requires a little time to become conscious of distortion and a millisec is not nearly a long enough period of time.

Psychoacoustic effects also make the delay in recovery at the end of a word permissible. There is a carry-over of the masking effect for a fraction of a second after the end of each word, and background print-through will therefore not be heard even if it is present within a few millisec of the end of a word.

The antidistortion amplifier has one unusual requirement in that it must produce a full output on a small input signal, and little increase of output with a 40-db increase in input. More important, there must be no tendency for cut-off bias to accumulate on any of the grids. This is avoided by the series grid-isolation resistors shown in Fig. 3.

One final detail is necessary to

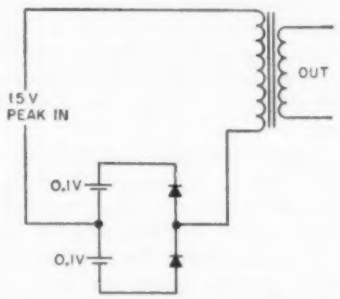


FIG. 1—Elements of biased-diode squelch

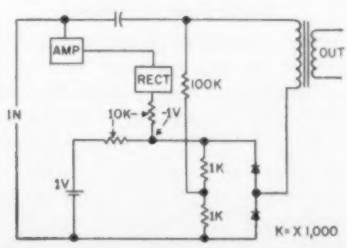


FIG. 2—Basic distortion-reduction circuit

Biased-diode type of quieting automatic-volume-control silences audio channel whenever signal drops to 40 db below peak. To reduce distortion and maintain diode conduction throughout modulation, a portion of the signal is rectified and applied to the diodes through a delay circuit. Constant level background noise is maintained by applying his signal to channel whenever quieting occurs.

Magnetic Tape Echoes

make the operation of the device smooth and unobtrusive. A background hiss must be inserted. Careful listening to the output without this added hiss gives the impression of a severe case of modulation noise. The pauses between words have an unreal-sounding silence to them, and each word brings with it room tone, tape hiss and tube noise.

The cure is shown in the schematic of Fig. 3. Shot-effect noise in a triode having only 4.5 v across its filament is amplified and fed into the output so that the overall signal-to-noise ratio is not degraded. The hiss voltage is applied in series with a large isolating resistor between the bottom of T_1 and ground. When suppression takes place, there is no significant input signal, the diodes are an open circuit and the hiss voltage is fed to the output terminals of the equipment.

In the presence of a signal the diodes become conducting, grounding the bottom of T_1 and shorting the hiss voltage. Thus hiss is added only when needed, making the apparent background fairly constant.

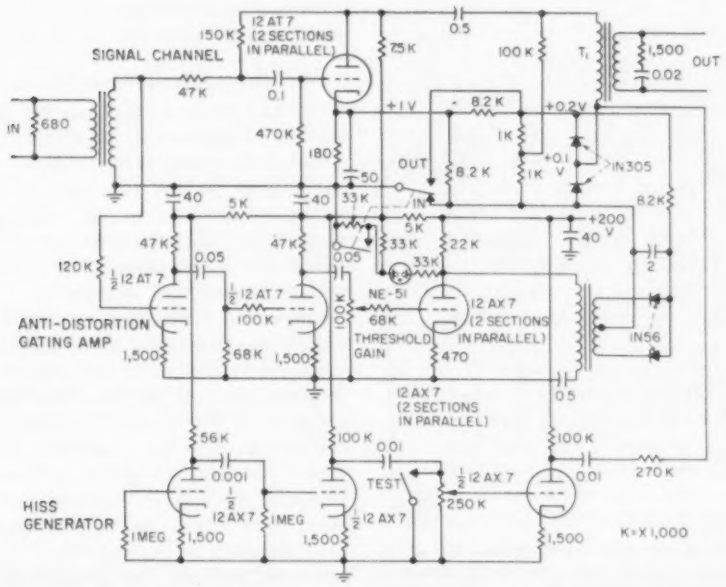


FIG. 3—Circuit of print-through suppressor. In-out switch permits operation as straight amplifier and test switch shorts output of hiss generator for A-B test

Low-Frequency Noise

If the original program material should contain low-frequency noise such as low-level hum, rumble or air-conditioner noise, this will be suppressed also. Reinsertion of this type of noise is neither necessary nor desirable. Even though the noise comes through during each word, it is largely masked and the subjective effect is more pleasing if it is suppressed.

For operating convenience in adjusting the threshold gain a small neon-bulb indicator is provided. This lights when sufficient voltage is present to decrease the bias on the diodes sufficiently.

At the inception of this design, 5 db of print-through reduction was considered to be a worthwhile improvement. In practice at least 10 db is usually realized. Even though some trailing sibilants are somewhat shortened, tapes otherwise inacceptaby echo-laden are again usable.

Specially designed cathode-ray oscilloscope permits selected laboratory techniques to be applied in field maintenance of reciprocating engines used in industrial and marine service. Display on cro shows cyclic engine events in time sequence. Instrument monitors ignition, vibration and pressure of spark-ignited or diesel engines and presents data on five-in. screen. Ignition mistiming can be detected within one degree of crankshaft position. Scope connections are made without necessity of engine shutdowns

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Scope Analyzes

OSCILLOSCOPES have been used extensively in laboratories and in commercial aircraft for comprehensive engine studies.[1] They have been adapted to analyze ignitions systems in automobiles, monitor engine operation in aircraft engine test cells, study detonation characteristics and evaluate dynamic operation of valves.

Until recently, cro techniques were not practiced in field maintenance of industrial and marine natural gas, dual fuel and diesel engines. The engine analyzer described in this article is designed for special use as a maintenance tool to efficiently monitor these engines without requiring expensive shutdown. The 36-pound, hand-portable unit visually displays information formerly obtained from as many as three electronic instruments and it enables maintenance personnel to check engine ignition, vibration and pressure for possible malfunctions with ease.

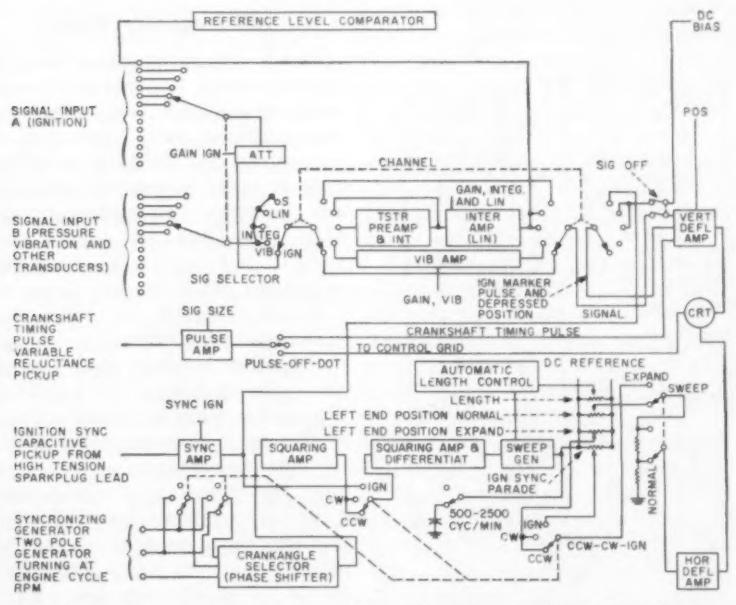
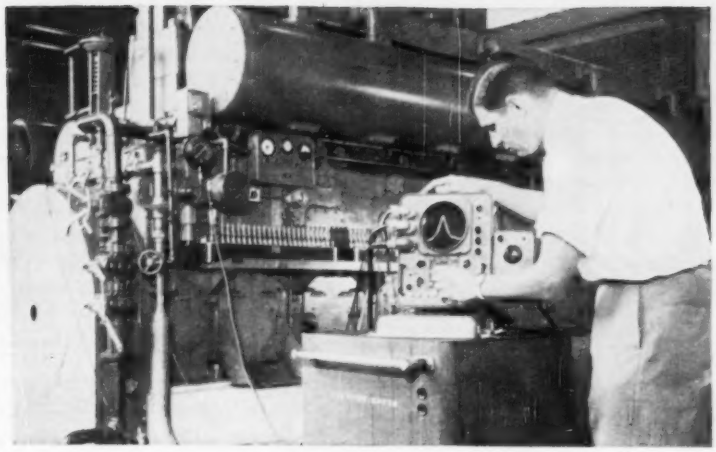
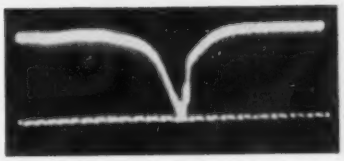


FIG. 1—Block diagram of cro engine analyzer. A sweep is driven across the crt in time with the engine. Resulting trace line displayed is responsive, in the vertical direction, to signals from ignition, cylinder vibration and cylinder pressure. Connections are made to the flywheel, ignition primary circuit, and two to a power cylinder. Timing the analyzer to the engine is done by a fifth pickup located near a mark on the flywheel

Design Requirements

In designing an analyzer for industrial engines the most difficult problem to solve is weighing the versatility factor with simplicity of operation. These requirements tend to be incompatible since an extremely wide variety of types and components of engines are in common use. Some of the following design requirements therefore become apparent: select for analysis important engine variables that are common to the largest number of engines, provide for simple connections that may be made without stopping the engine, minimize the number of operating controls and use detent positioned controls wherever possible and present the results in a direct form that can be read and interpreted easily.





View of cylinder pressure pattern with the reference line superimposed

Author is shown operating controls of analyzer to check a large natural gas engine. Ignition, vibration and pressure data of the reciprocating engine are presented as simple patterns on five-in. screen. No engine shutdown is required to operate the 36-pound portable unit—FRONT COVER

Reciprocating Engines

The features of particular interest are the pickups used with the instrument, the integrating and linear amplifiers to accommodate pressure and certain commercial pickups, the provision for crankshaft timing signals superimposed directly on the oscilloscope pattern, and the method of comparing relative amplitudes of signals from the integrating or linear channels by superimposing a reference line on the pattern. By using the cathode ray tube as an indicator, accurate measurements are made directly from the sources generating the signals. This permits simpler and less costly design of the linear time base and vertical amplifier.

The choice of pickups to be used has a significant effect upon the design of an engine analyzer. When a transducer produces a voltage that is a function of a cyclic engine event, this event can be displayed on the engine analyzer in terms of measured crank-angle degrees. Cyclic operation can then be evaluated. Strain gage, magnetostrictive, variable reluctance, capacitive and piezoelectric pickups have been used in engine analyzer work to observe dynamic operation of stresses in bolts, power and compressor cylinder pressures, diesel injection pressures, injector valve motion, intake and exhaust valve motion.

The choice of events for analysis depends on the needs of the operator, the expense of the pickup and the difficulty of installation. All the transducers mentioned have been used in the laboratory to obtain answers to specific design problems. One may have to improvise, however, to make certain installations, such as the strain gage instrumentation of an integral fuel pump and injection nozzle. Generally, in the field, simple, inexpensive pickups that give comprehensive information and are easy to apply should be used.

Display Technique

In the engine analyzer presented, cylinder pressure, sounds in the engine structure and ignition voltage are given in terms of crank-angle degrees. This is done, as shown in Fig. 1, by feeding the pickup signals to the vertical deflection circuit of the crt while a linear time base sweep generator, synchronized to the engine-cycle frequency, generates a horizontal deflection-signal that is directly proportional to crank-angle rotation.

The phase of the synchronizing signal can be shifted by a crank-angle selector control to start the horizontal sweep at any crank-angle position. This position can be read from the selector dial. To provide even more accurate timing and to enable the operator to read crank-angle position directly from the oscilloscope pattern, timing marks generated directly from the flywheel of the engine are displayed as either vertical spikes or dots superimposed on the oscilloscope pattern.

Operation

Once the analyzer has been set up, the pickup signal and the corresponding vertical channel are selected by two switches. The sweep, full engine cycle or one-eighth of an engine cycle, is selected by a rotary switch. The crank-angle is selected by the phase shifter control and the timing marks, vertical spikes or intensified dots, are selected by a toggle switch. Pressures from respective cylinders are compared by an adjustable reference line superimposed directly on the scope pattern. Height of the reference line is read from the adjusting dial.

One integrated package contains the many components required to present the respective signals together with a time base of constant sweep length capable of operating

over the complete range of engine revolutions per minute.

Pickups

To simplify wiring and switching, self generating pickups are used. The crankshaft timing pulse pickup, illustrated in Fig. 2A, is a variable reluctance type comprising a magnet and coil. It responds to magnetic discontinuities in the flywheel and is polarized to produce timing marks from ¼-in. diam holes spot-faced in the flywheel. If vanes or punchmarks are used, the leads from the pickup must be reversed. If the pickup output is passed through the integrating channel, a picture of the magnetic contour of the flywheel is obtained so that features such as flywheel runout are shown clearly.

The pressure pickup is also a variable reluctance type and consists of a coil surrounding a magnet that is positioned close to a special steel diaphragm. This pickup configuration, shown in Fig. 2B, was made practical with the advent of new, high-strength alloy steels which produce sufficient deflection without exceeding the elastic limit.

The pickup is rated at 1,000 psi and responds to rate of change of pressure. It is relatively inexpensive to build, being little more complicated than the electromagnetic pulse pickup. The pressure pickup will withstand rough use and operating temperatures as high as 350 to 400 F. An air-cooled adapter is furnished for high output engines.

Figure 2C is a cross-sectional diagram of the vibration pickup which is magnetostrictive and responds to rate of change of acceleration. It resembles a rugged microphone that listens to vibrations in metallic structures. This basic type of pickup is simply constructed and has been used commercially for many years to indicate the presence of combustion knock and metallic impacts within an engine. To improve s/n ratio, the pickup is used with a tuned amplifier.

Ignition-System Analysis

No pickup is required for ignition analysis because voltages developed across ignition system breaker points or impulse generator coils yield a great deal of information about ignition system operation. Since industrial engines are large, ignition circuit constants are affected and it is often necessary to use individual coils for respective cylinders and sometimes even for individual sparkplugs. Switching of ignition circuits must then be provided. The same switching control is used to select multiple vibration pickups. Multiple pickups are used for permanent analyzer installations such as marine diesels.

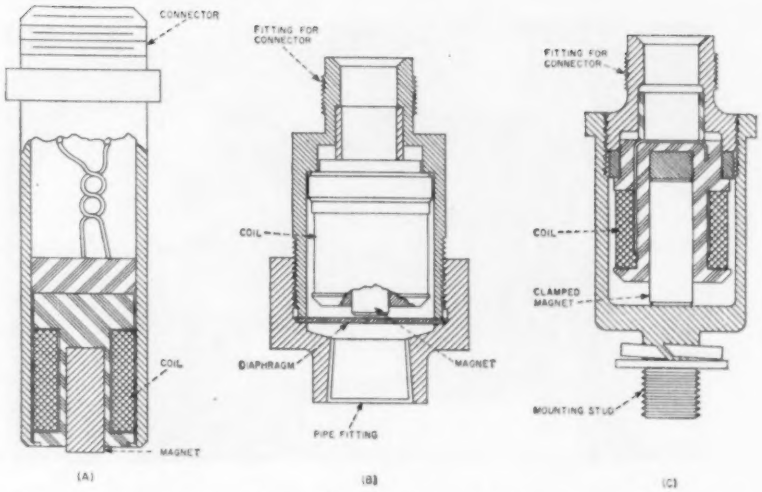


FIG. 2—Crankshaft timing pulse pickup (A) responds to magnetic discontinuities in the flywheel. Pressure pickup (B) responds to rate of change of pressure, while magnetostriction pickup (C) responds to rate of acceleration

Synchronization

Synchronization of the sweep to any crank-angle position throughout the engine cycle is accomplished by a three-phase, two-pole, permanent magnet generator driven so that the rpm corresponds with the number of engine cycles per minute. The phase shifter control referred to previously and indicated in the analyzer block diagram operates in conjunction with the synchronizing generator.

Synchronization of the sweep to any sparkplug firing event is accomplished through the capacitive pickup afforded by a simple battery clip attached to the high tension lead of a sparkplug. A pickup with special fittings is required for shielded ignition systems. This type of synchronization is sometimes used for a quick, qualitative evaluation of a particular engine event. A position control is provided on the analyzer to parade all the engine cycle events across the cathode ray tube screen when this type of synchronization is used.

Pressure-Time Diagrams

Field experience has indicated that cylinder pressure is the principal common denominator between piston engines. Pressure analysis can be performed on any engine equipped with cylinder cocks that provide access to the combustion chambers. Several limitations of previously available equipment were considered: a) mechanical pressure indicators respond too slowly to show the rapid pressure changes that occur in engines, b) mechanical indicators do not show clearly and continuously the effects of cycle-to-cycle variations, c) electrical pickups have required associated equipment that is too complex for use in general maintenance and d) electrical pickups have been costly and delicate.

The use of an electronic indicator removes limitations a) and b). The engine analyzer itself, being designed as a self contained unit especially for use with engines, removes limitation c). To overcome limitation d) the improved pickup described in the previous section of this article was designed.

To obtain the conventional pressure-time diagrams associated with piston engines, the pressure-

rate pickup output must be integrated and then amplified sufficiently to obtain adequate deflection. To integrate at low engine-cycle frequencies, 4 to 5 cps, a time constant of 0.5 sec is required. Because of this time constant and the output characteristics of the pickup, a gain of 100 db is necessary to produce the desired deflection. The low-frequency and high-gain requirements make stability considerations in the initial amplifier stages important.

For the first stage, the most critical, a 4JD1A17 transistor, in common-emitter configuration is used. See Fig. 3. The transistor stage boosts the pickup output by a factor of 60 without introducing hum, microphonics or the low-frequency drift that ordinarily results from changes in cathode temperature when a vacuum tube is used. A transistor is well suited to this application because it facilitates direct coupling to the low-impedance pickup and because a high output impedance is desired for the integrating circuit that follows. The stage is stabilized by feedback and it operates over a temperature range of 32 to 160 F with a change in gain of less than 10 percent.

Amplifiers

The intermediate amplifier consists of two sections of a 12AY7, followed by a section of a 12AU7 that serves as a cathode follower and acts as an input for the chopped reference signal from the level comparator. The 12AY7 was selected because of its low noise characteristic.

Filament current for the tube is regulated by a ballast tube to minimize the effect of power line variations on cathode temperature. The first section of the 12AY7 has a 0.02-μf capacitor connected between grid and plate when the integrating channel is selected and serves thus as a Miller integrator. The second section of the 12AY7 is capacitance coupled to the first and provides a gain of 20. The gain control was placed at the output of the first section of the 12AY7, rather than at the cathode follower to permit higher signal inputs before saturation occurs so that the linear channel can accept signals from pickup preamplifiers.

Power for the transistor stage and for the plate supply of the intermediate amplifier is obtained from batteries to isolate these stages from line voltage variations. Since the current demand is only five to six milliamperes, battery life of 80 to 100 hours is to be expected.

The vertical deflection amplifier is a 12AT7 utilizing a cathode-coupled paraphase circuit stabilized by feedback. The ignition marker pulse and the crankshaft timing pulse are fed to the paraphase grid. As shown in Fig. 1, d-c bias is introduced automatically when the integrating and linear channels are selected. This depresses the vertical position 1¼ in. to display pressure patterns symmetrically. For observation of other types of patterns in these channels the vertical position control may be used to center the pattern.

The plate supply to the deflection amplifier is not regulated because the reference signal is mixed with the pressure signal ahead of the deflection amplifier. When slight deflection changes occur as a result of changes in power line voltage, both the pressure and reference line signals are moved by the same amount and are not displaced with respect to each other.

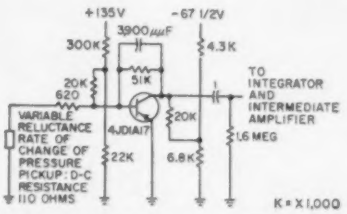


FIG. 3—Schematic of transistor preamplifier, the first stage in the analyzer pressure channel. This stage, stabilized by feedback, boosts the pressure pickup output by a factor of 60

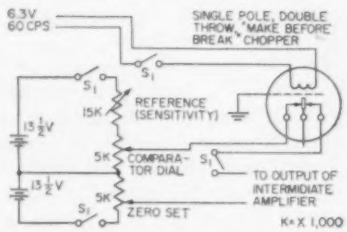


FIG. 4—Schematic of reference level comparator, used to measure relative amplitudes on crt. The comparator potentiometer and dial permit reading of deflection in terms of linear scale divisions

Pattern Amplitudes

The reference level comparator measures relative amplitudes of waveforms displayed on the crt in terms of graduations on a dial. A photograph of a cylinder pressure pattern with the reference line superimposed is shown. The reference level comparator circuit appears in Fig. 4. It consists of a battery source of d-c reference potential, a four pole on-off switch, two potentiometers to define the slope of the straight line relationship between voltage and deflection for the signals being displayed, a precision potentiometer and dial to permit reading the deflection in terms of linear scale divisions and a chopper.

The four-pole switch is shown in the off position. The chopper contacts are shown closed, which is the condition for both contacts when the chopper is inoperative. The chopper mixes the d-c reference level with the vertical signal 10 percent of the time 120 times a second. One pole of the on-off switch prevents shorting the vertical signal to ground when the make-before-break chopper contacts do not vibrate.

The remainder of the circuitry is generally similar to that described previously.[1] The arrangement of the circuitry in the new configuration is indicated in the block diagram. A principal objective of this circuit arrangement is to provide suitable switching so that the operator can perceive analysis in terms of engine functions.

The deflection amplifiers, the sweep generator and length control, the squaring amplifiers, the ignition synchronization amplifier and the vibration amplifier are contained in a printed circuit board assembly.

Reference

(1) V. C. Cetrone, Airborne Engine Analyzer, Electronics Mar. 1948.

Saturable Reactors

Magnetic modulator uses saturable reactors to convert input sine wave into narrow, high peak-power output pulses. Basic action of current-pulse compression with magnetic modulators is explained. Polarizing and differentiating circuits, delay-line wave shaping, pulse permeability measurements, cancelation effects and related features leading to improved design are discussed

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HIGH-POWER, extremely narrow current pulses in magnetic modulators are generated from a sine wave input by using saturable reactors in resonant circuits.

In performing this operation the saturable reactor functions first as an inductive component, second as a switch and third as part of a resonant circuit. When used in this trimoded capacity it may be called a pulsactor.

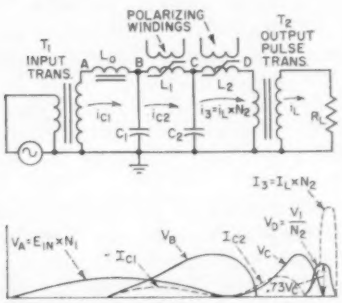

FIG. 1 — Polarized two-stage magnetic modulator with current and voltage waveforms for each reactor resonant stage

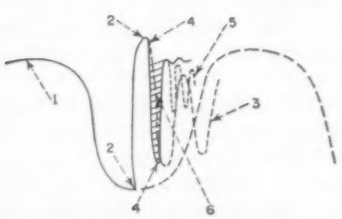

FIG. 2—Switching and ringing waveforms. Resonant input sine wave (1), flattened by polarization first switching (2), ringing which would occur due to first switching (3), second switching (4), ringing which would occur due to second switching (5), and output pulse (6)

The input current waveform is compressed in a series of pulsactor resonant circuits into narrow, high power pulses of current. Pulses obtained from magnetic modulators using these reactors are sufficient to modulate high-power magnetrons. Recent advances in high permeability nickle-iron alloys have improved reactor switching action and lowered core losses.

In the transient operation of a modulator, a saturable reactor cyclically changes inductance or becomes a short circuit. A single physical coil winding can perform many separate functions. Unsaturated, it can act either by itself, as an auto transformer, as a variable circuit impedance or as part of a resonant circuit. As a saturated inductance it can act as a switch, as a part of a resonant circuit, or as a multisection winding acting at saturation as a delay line or pfn. Since the inductance of the saturable reactor may be part of a resonant circuit, each change in inductance may be considered to create an independent passive network with its own current and voltage waveform.

Charging and Switching

In its most basic form the magnetic modulator is a series of saturable reactors in resonant circuits. When the resonant frequency of a stage is reached, the reactor switches and shock excites the next stage at a higher frequency. By repeating the resonant charging

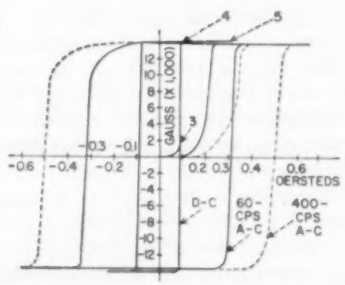

FIG. 3—Magnetization characteristics for high permeability iron

action and switching in several stages, successively resonant excited currents are produced which form a narrow, high-amplitude output current pulse. A series of increasingly higher frequency resonant circuits make up a current compression modulator. The operation is basically different from a conventional line pulser which develops its narrow output pulse in one off and on switching cycle of the thyratron which discharges a pulse forming delay-line network.

Input for a magnetic modulator may be either a sine wave or a triggered pulse at radar repetition frequencies. In the conventional a-c case, using sine-wave input, the magnetic circuits are polarized to allow switching only once for every sine-wave cycle. Charging action for each resonant circuit therefore occurs at the input frequency.

In the two-stage magnetic modulator shown in Fig. 1 the energy

Fire Radar Magnetrons

Components for a small magnetic modulator include: charging reactor (1), first saturable reactor (2), polarizing coke (3), second saturable reactor (4), charging capacitors (5), third saturable reactor (6) and pulse transformer (7)

transfer involves three different resonant frequencies which are determined by combinations of the various capacitors and the unsaturated and saturated inductances. A graph of the current and voltages waveforms at the particular frequencies involved in the three interrelated circuits is shown below the circuit diagram. The rapid switching of energy across the resonant circuits produces a narrow high-power output pulse. Energy transfer occurs at essentially equal voltages across the charging capacitors C_1 and C_2. A timewise compression of the successive current waveforms results so that, for a constant transfer of power, they become increasingly narrow.

Design Considerations

The overall action may be divided into four steps: (1) self resonance of the modulator input components at the prf of the sine-wave source, (2) progressive switching in the cascaded circuits, (3) successive self resonance of the saturated reactors and their associated capacitors and (4) the transfer and wave shaping of pulsed energy from the last resonant circuit to the load. During the process all tuning capacitors that store the energy remain at a constant peak voltage.

Self resonance of the input circuit, which occurs at the sine wave input frequency ω_1 delivers a maximum voltage across C_1 equal ideally to π times the input voltage multiplied by the input transformer ratio N_1. The unsaturated inductance L_{1u} may be neglected and capacitor current i_{C1} decreases to zero at maximum voltage at point B.

At the instant the voltage V_B across C_1 reaches a maximum L_{1u} saturates becoming L_{1s} and acts as a switch to transfer the charge of C_1 to C_2 through current flow i_{C2}. After switching the network consisting of L_{1s}, C_1 and C_2 becomes resonant to another frequency ω_2 and the current i_{C2} through C_2 rises rapidly causing the circuit to ring at its natural frequency. As current builds up in the resonant circuit, L_{1s} returns to its unsaturated state and the voltage at point B decays.

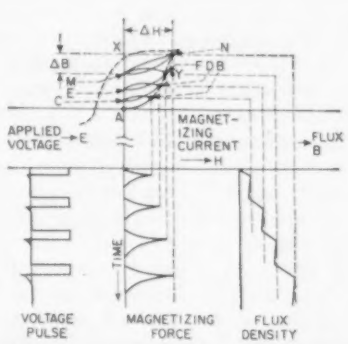

FIG. 4—Continuous plot of magnetizing force and flux density before magnetic conditions stabilize

The voltage V_c across C_2 reaches a maximum at the same instant L_2 saturates, becoming L_{2s}. The energy stored in C_2 is then carried to the load by current i_2. During the output circuit discharge action L_1 remains unsaturated and has no effect on the output circuit. With optimum energy transfer the current through the load is a transient, described by the equation: $V_D = (0.73\ \pi\ E_{1s}\ N_1\ \text{Sin}\ \omega_2\ t)/2$ where $\omega_2 = (L_{2s} \times C_2)^{-1/2}$ is the natural frequency. V_D is the voltage across the equivalent magnetron load reflected across the primary of T_2. It has a maximum amplitude equal to $0.73\ V_c$.

Waveforms obtained in actual operation are more like those shown in Fig. 2. Resonant sine waves of each stage are drawn with dotted lines and the pulse, which is actually developed, with a solid line.

Basic Magnetic Considerations

Good saturable reactor action depends upon the use of high-permeability iron and the application of polarizing fields. High permeability iron works on a steep B-H curve and therefore gives rapid flux changes and high induced voltages. With sharp cornered hysteresis characteristics the switching action of the pulsactor produces good current pulse compression because of the high ratios of unsaturated to saturated inductances. Use of polarizing fields will increase the effective permeability beyond normal values.

These generalizations appear more vividly when the magnetic properties of some modern high-permeability irons are considered. For instance, the d-c hysteresis loop shown in Fig. 3 has a flat slope or flux change from point 4 to 5. The flux change is only a few gauss under operating conditions compared to an extremely high flux change when going from point 3 to 4. Since inductance depends on permeability, the flux changes give

a high ratio of unsaturated to saturated inductance. This high ratio is ideal for switching action. The reactor functioning as a switch has a low impedance and the shunting effect of the unsaturated coils upon the rest of the system is reduced. The resonant frequencies derived from the low saturated inductances of the switches are higher than in poorly saturated circuits and give greater current pulse compression. In practice it is possible to achieve saturated to unsaturated inductance ratios of as high as 2,000 to 1 and to use coils in successive stages with inductance ratios between 20:1 and 100:1.

Polarizing Fields

An important factor in the design of saturable reactor circuitry is the polarizing field, sometimes referred to as magnetic biasing. When applied to magnetic components carrying pulse voltages it enables adjustments to improve overall performance. Chief effect of the polarizing field is control of pulse permeability. The pulse permeability constant has different implications from the initial, average or maximum permeabilities common to conventional magnetic circuits.

To define permeability, suppose a narrow voltage pulse, 1 to 5 μ sec, is applied to a coil with a magnetic core, as shown in Fig. 4. Examination of the magnetization curve before the associated circuits and the magnetic conditions stabilize themselves, shows that the first flux loop starts with unmagnetized iron at point A and, as the magnetizing force increases, goes from A to B and back to C where it remains at the residual flux density until the next applied pulse arrives. The second flux loop, starts at C goes to D and returns to its residual magnetization at E. The third loop from E to F and so on. Forward tips of the flux loops ascend the basic magnetization curve.

Finally the flux arrives at a closed stabilized loop M, N with residual and maximum flux values such that the decrease in flux when pulse voltage is removed exactly equals the increase in flux due to applied voltage. Pulse permeability μ_{11} of the iron is defined as the slope of the axis of the last loop. It is $\Delta B/\Delta H$ or in terms of the magnetization curve in Fig. 4 it equals the ratio of distances $(n\text{-}y)/(m\text{-}x)$. A plot of the flux density and magnetizing force during the changes is shown in Fig. 4.

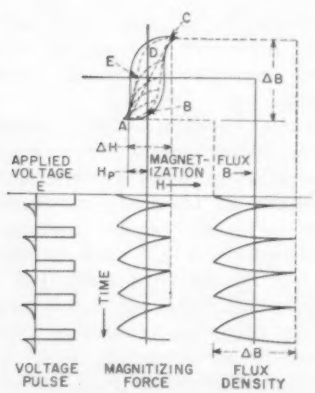

FIG. 5—Pulse permeability under the influence of a negative polarizing field

Pulse Permeability Figure

Permeability of the iron after operating conditions have stabilized is a constant which can be measured. It is used to calculate the inductance of unsaturated reactors. The pulse permeability figure is a complex quantity which depends on the value of the applied pulse voltage, on the ratio of the pulse width to the prf and on other circuit considerations such as Q or loading and distributed capacitance. It can be changed by magnetic biasing of the core.

The pulse permeability μ_{11} is not the permeability determined by the initial magnetization curve either at its points of initial, maximum or minimum slope. In the highest permeability irons, under unbiased conditions, pulse permeability runs around 2,000 as contrasted to the initial permeability of 600 and a maximum permeability of 250,000.

Pulse permeability under the influence of a negative polarizing field, opposed to the field caused by the applied pulse voltages, is shown in Fig. 5. The flux loops start at A and with a polarizing field H_P, which is slightly less than the saturation flux, the flux and magnetizing conditions immediately stabilize. The final loop is $ABCDEA$. It has a B-H slope corresponding to the axis AC. By adding a polarizing field so that the flux loops always start at a negative flux density equal to the saturation density, the slope in the final flux loop exceeds that of Fig. 4, and, in effect, the pulse permeability is increased.

In actual practice the optimum value is arrived at by adjusting the polarization field and the applied voltages to give stabilization at some flux value slightly less than the saturation value of the particular iron being used. In the case of high-grade iron with a proper polarizing field it is possible to use a total swing approaching 30,000 gauss.

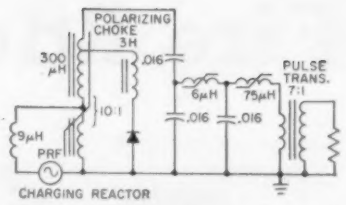

FIG. 6—Amount of polarization changes with operating level making modulator partially self-regulating

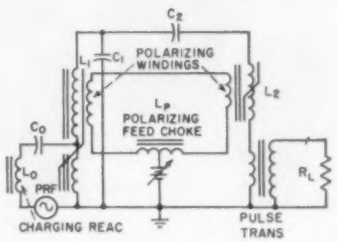

FIG. 7—Magnetic modulator with autotransformer primary resonance and cancellation feedback

Operational Circuits

Figure 6 shows a circuit using a combined autotransformer and saturable reactor in the first stage with self polarization. A portion of the input energy is rectified and the unidirectional current used to magnetically bias the core. The arrangement saves a transformer assembly, places the charging choke on the primary side reducing its size and produces an output which is partially self-regulating since the amount of polarization changes with the level at which the device operates. The autotransformer must operate over wide ranges of

permeability while still maintaining resonance at the driving prf.

Fig. 7 is a variation of the autotransformer using the charging capacitors in a slightly different manner. First, some of the resonant circuit is transformed from the secondary to the primary by connecting C_s in series with L_p. Any leakage between the primary and secondary of the autotransformer is cancelled out when C_s is tuned. It also allows C_s to be placed in series with L_2 adding to pulse sharpening at this point because it reduces the second circuit total capacitance as well as acting as a differentiator for voltages developed in L_1.

Polarization of an intermediate stage shown in Fig. 7, serves two purposes. First it cuts off the positive pulse developed by the differentiating action of C_s and second it eliminates undesired feedback of output pulses to input circuits.

The polarizing windings are supplied through a tapped isolating choke which offers additional advantages. The choke isolates the polarizing supply from signal voltages.

By sending the polarizing current through a center tap to buck out the d-c fields it relieves d-c saturation and permits a smaller feed choke winding for a given inductance. Since signal voltages appear across the choke, it can be used simultaneously as a pulse transformer which can be a-c polarized so that the fields derived from the output pulses can be made to cancel the particular portion of themselves which would be normally reflected back into the input.

Delay Line Waveshaping

Economy of parts and additional waveshaping necessary to square up the triangular pulse normally generated in the last stage are provided by the delay line shown in Fig. 8. By tapping the reactor winding and adding capacitors to ground, the network becomes a delay line in addition to being a switch and a high inductance. The capacitors from the taps to ground offer negligible effect to unsaturated operation but at and during switching produce an improved output pulse waveform. The circuitry provides better impedance matching and helps to compensate for effects produced by the output transformer. It also allows easy manual adjustment of the output pulse width by adjusting the polarizing current control resistor. Some effects of the polarizing field in the last reactor are still present, even at saturation.

Design Calculations

The basic design constants stem from the conditions stated in Fig. 1 and from the required peak power output, duty cycle and pulse

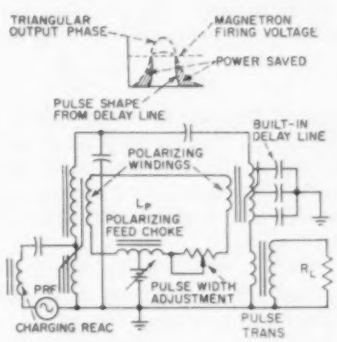

FIG. 8—Built-in delay line squares up triangular pulse normally generated in last stage of magnetic modulator

width. From the values of Fig. 6 and with relationships shown in Fig. 7 the value of the charging capacitor voltage V_c can be determined. Taking a set of typical constants existing in a small modulator used to fire a magnetron:

$$V_c = \frac{1}{0.73} \times \frac{V_a}{z}$$

$$= \frac{1}{0.73} \times \frac{5{,}600}{7} = 1{,}100\ v$$

where V_a is the magnetron firing voltage (5,600 v) and N_s is the output transformer turns ratio (7:1). From the basic energy equation, $PT = 1/2\ CV^2$ the charging capacitor is

$$C = \frac{2}{n} \times \frac{1}{V_c^2} \times P\ T \text{ farads}$$

$$= \frac{2}{9} \times \frac{1}{(1{,}100)^2} \times 9{,}000 \times 10^{-6}$$

$$= 0.016\ \mu f$$

where n is the output transformer efficiency (0.9), T is the modulation pulse duration (10^{-6} sec), P is the peak power (9,000 w) and F is the pulse repetition rate (2,000 cps).

Knowing the capacitor voltage and size in terms of output power and remembering that the first circuit is resonant at the pulse repetition frequency and since the first reactor inductance has a definite ratio to the charging choke, the unsaturated inductance of the first reactor may be calculated.

$$L_{\mu 1} = \frac{n_e}{2}(1+\sigma) \times \left(\frac{V_c}{2\pi f}\right)^2 \times \frac{1}{P\ T}$$

where n_e is system efficiency (0.33) or σ is the ratio of the reactor inductance to the charging choke. If $n_e \times (1 + \sigma)$ is combined into a constant K which equals one then

$$L_{\mu 1} = \frac{1}{2} \times \left(\frac{1{,}100}{6.28 \times 2{,}000}\right)^2 \times \left(\frac{1}{9{,}000 \times 10^{-6}}\right) = 0.422 h$$

With this inductance, core sizes and number of turns can be calculated provided the pulse permeabilities available in the iron core are known. The inductance of succeeding reactors may now be calculated with selection of suitable ratios from which is determined the current pulse compression when working with practical ratios of saturated to unsaturated inductances.

The transient voltage waveforms encountered after saturation, as shown in Fig. 2 probably may give some trouble. For instance when L_1 starts to ring after saturation it is found that although by differentiating the pulse developed at this point and thus preventing low-frequency prf input energy from passing on through the circuit, it is in addition necessary to polarize L_2 to eliminate the positive excursions on the front corner of the output pulse waveform. In some cases, even with polarization, it is necessary to place a diode across the primary of the pulse transformer.

References

(1) W. S. Melville, The use of Saturable Reactors as Discharge Devices for Pulse Generators, *Proc IRE*, p 185, 53, 1951.

(2) K. J. Busch, A. D. Hasley and Carl Neitzert, Magnetic Pulse Modulators, *BSTJ*, 34, p 943, 1955.

(3) R. A. Mathias and E. M. Williams, Economic Design of Saturating Reactor Magnetic Pulsers, *AIEE Trans*, Communication and Electronics, p 169, 1955.

High-Speed Tester

Production tube tester gives rapid indication of opens and shorts with direct-reading localization by neon lamps. Memory circuit holds indication of intermittent tap shorts. Seven tube types are covered, but others may be accommodated with simple wiring changes. Most-used types are tested in groups of four at a time. Minor changes allow tests of special tubes

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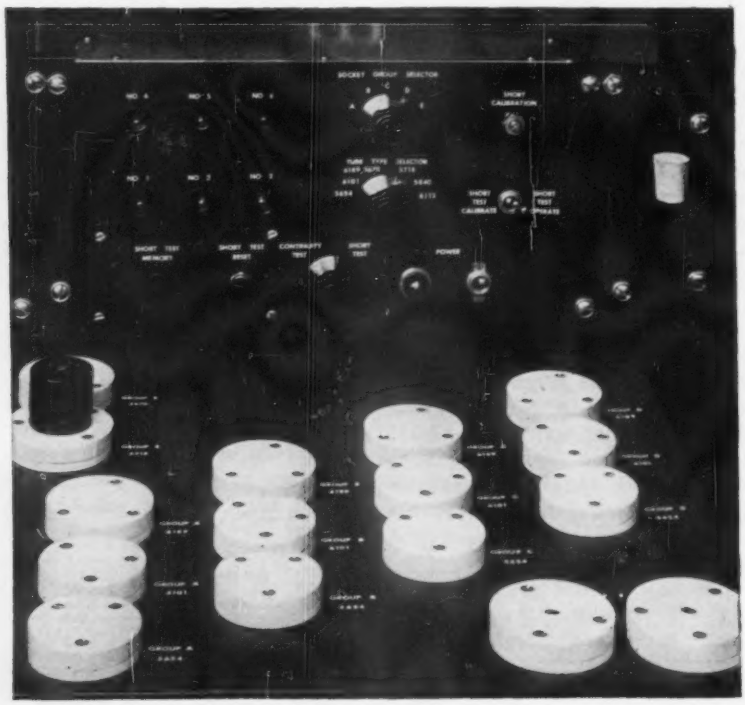
TUBE TESTERS are not usually convenient for rapidly locating shorts and discontinuities in large numbers of electron tubes. The short-testing function usually has a four or five-position switch and a single neon-lamp circuit. For shorted elements the switch positions at which a glow appears are noted and a table is referred to for pin-pointing the short. No permanent indication for tap shorts is provided. The g_m reading usually serves as the only continuity indication, but this is not always conclusive nor does it localize the discontinuity.

The short-continuity tester described here is a high-sensitivity device for rapid checking of up to four tubes of a given type at a time. It also contains a memory feature for tap shorts. Although designed for seven particular tube types, the unit can accommodate others with minor wiring changes.

Short Testing

The short-test circuit gives permanent indication of an intermittent tap short. It also localizes precisely all sustained shorts, and those tap shorts in which the time



Three groups of four long-life tube sockets are used for most-required types. Octal adapter is used for subminiature types. Cork hammer aggravates tap shorts

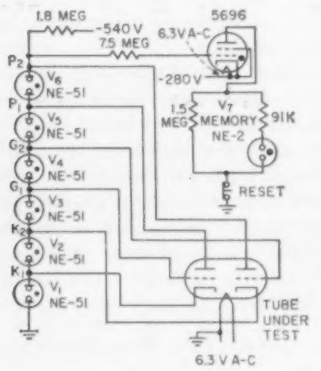


FIG. 1—Simplified short-testing circuit

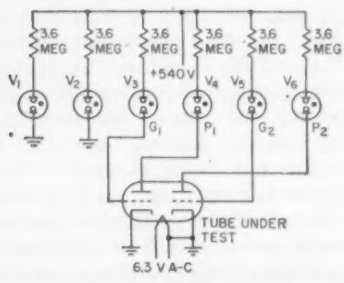


FIG. 2—Simplified continuity testing

Checks Tubes in Groups

is sufficient for the eye to sense an indication on the panel lamps. Localization is made by noting which neon lamp or lamps are extinguished out of six normally glowing. The memory indication is given by the glowing of a seventh normally - extinguished lamp.

The maximum short resistance for indication, hence the tester sensitivity between any two elements of the tube under test, is 220,000 ohms for the memory and approximately 400,000 ohms for the six-lamp localization display. A simplified schematic of the short-testing circuit is given in Fig. 1. The elements of the tube under test are connected to the junction points of the lamps. The voltage drop across each of the neon lamps is approximately 50 v. The current is fixed at approximately 0.133 ma by the source voltage and dropping resistor.

If a resistance of approximately 400,000 ohms is placed between K_2 and G_1, for example, all of the V_2 current would be routed through the resistance and the lamp would extinguish. This value of resistance, which is the lamp voltage divided by the series current, is thus the basic localization sensitivity of the short tester. If the shorting elements are not adjacently connected, such as K_2 and G_2, V_2 and V_4 would both extinguish and the sensitivity would be proportionately increased to 800,000 ohms. Since one side of the heater is grounded, a short between K_1 and heater, for example, would cause V_1 to extinguish.

The grid of the thyratron is connected to the top of V_8 through the limiting resistor and is at a constant potential in the absence of shorts. The cathode is returned to a fixed voltage to bias the tube beyond the firing voltage. When a short of sufficient magnitude occurs between any two elements of the tube under test, the thyratron grid becomes less negative, causing the tube to fire and V_7 to glow. This memory lamp continues to glow until the reset button is depressed, re-

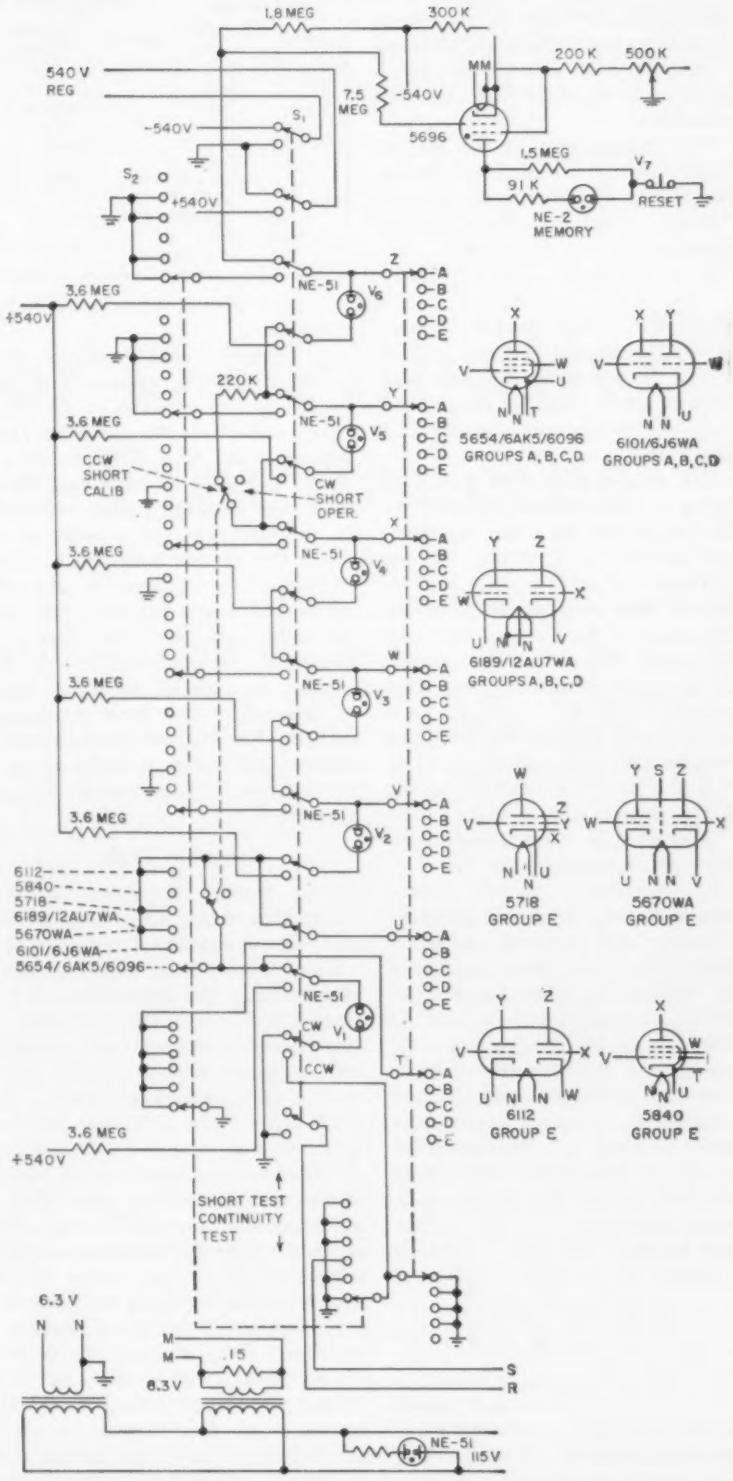


FIG. 3—Complete circuit diagram and tube connections for short and continuity tester

gardless of the voltage at the grid. The time constant of the grid circuit including stray capacitance is such that a short of only 100 μsec duration is sufficient at maximum sensitivity to fire the tube. Thus the circuit is fast enough for practically all tap-short defects encountered.

The change in grid voltage ΔE resulting from an adjacent-element short of the maximum design sensitivity of 220,000 ohms can be computed from the equation

$$\Delta E = (E_L R_2/R_1 + 6E_L - E_B)/(1 + R_2/R_1)$$

where E_L = lamp voltage (approx 50 v), E_B = supply voltage (−540 v), R_1 = resistance of adjacent-element short (220,000 ohms) and R_2 = series-dropping resistor (1.8 megohms).

The value of ΔE with the given values is approximately 18 v. To this value must be added the negative critical grid voltage of the thyratron to obtain the grid-to-cathode bias voltage necessary for this sensitivity. The critical grid voltage for the 5696 with suppressor grid tied to cathode and plate voltage of 300 v is −2.5 v. Thus the required bias is 20.5 v. Since the nominal NE-51 voltage drop is 50 v the quiescent voltage at the grid is close to (50 × 6) or −300 v. The cathode must therefore be returned to about −280 v.

The sensitivity of the instrument to tap shorts is calibrated by adjusting the cathode potential with a voltage divider. A 220,000 ohm resistor is switched across one of the series lamps and the cathode voltage is varied in a negative direction until the thyratron fires as observed by V_7. The actual negative grid bias, as set by calibration, measures close to the computed 20.5 v. A regulated high-voltage power supply is required, as a 1-percent change in cathode voltage gives roughly a 10-percent change in memory sensitivity.

Continuity Testing

The continuity-testing circuit is quite simple. Cathode emission is utilized, all tube grids and plates being connected positive with respect to the cathodes. The same six neon lamps are used as with the short-testing circuit and all lamps will glow with a nondefective tube under test.

Table I—Fault Location Chart for Electon-Tube Type 12AU7

Discontinuity Location		Short Location	
Lamp	Element Open	Lamp	Elements Shorted
V_3	Grid 1	V_1	Heater
V_4	Grid 2	V_2	Cathode 1
V_5	Plate 1	V_3	Cathode 2
V_6	Plate 2	V_4	Grid 1
V_2, V_5	Heater 1 or Cathode 1	V_5	Grid 2
V_4, V_8	Heater 2 or Cathode 2	V_6	Plate 1
V_3, V_4, V_5, V_6	Heater center-tap		Plate 2

A simplified schematic of the continuity-testing circuit is given in Fig. 2. The cathodes of the twin triode under test are grounded and each grid and plate is connected to +540 v through an individual neon lamp and series-dropping resistor. If continuity is not present to a given element, its lamp will be out. For simplicity of operation all neon lamps which are not used for the particular tube type under test are energized by connection directly to ground, as with V_1 and V_2 of Fig. 2. Because of the large dropping resistors the current through each element and lamp is fixed at approximately 0.13 ma and all lamps glow equally.

Complete Tester

This tester was designed for seven tube types as shown schematically in Fig. 3.

Four tubes of a given type are plugged into the board and while their heaters are being energized, the operator throws a selector switch from one to another for testing. The 5670, 5718, 5840, and 6112 types have only one socket each while groups *A*, *B*, *C*, and *D* are four-socket positions for each of the multiple-testing types 5654, 6101, and 6189 (see photo). A cork mallet is the device used for tapping tubes.

A 2-position switch S_1 throws the operation from short test to continuity test. Most of the poles of this switch are used to switch the six neon lamps from the series operation of the former to the parallel operation of the latter. A 6-position, 8-pole switch S_2 is used as the tube-type selector, with one position for each type except the 6189 and the 5670. These are both miniature twin-triodes and are combined in a single switch position. Most of the poles of this switch apply grounds to the lamps not used in continuity testing.

Because of the maximum voltage ratings of the various tube types the order of connections between the lamps and the tube elements must be different for some of the tube types. This requirement is relevant to the short test but as a result affects switching for the continuity test also. Charts are prepared listing the tube defect as a function of the neon lamp display for both short and continuity test. A typical fault location chart for the 12AU7 is shown in Table I.

Special Circuit Details

Tube type 5654 has two cathode connection pins. To test continuity to both pins the two are connected in series between V_1 and V_2 in the short-test mode of operation. A discontinuity between the two pins breaks the series circuit, causing all lamps to be extinguished. For tube types having a single cathode terminal the connection between V_1 and V_2 is made by the tube-type selector switch in the short-test operation.

The 5840 has three cathode pin connections. To test continuity between two of the three pins, the same technique as for the 5654 is used. Continuity of the third pin connection is tested in the continuity-test operation. For this test the selector switch removes the ground from the first two cathode connections and the continuity-short switch grounds the third cathode lead *R* as shown in Fig. 3.

Tube type 5670 has an electrostatic shield between the triode sections which is brought out to a pin connection. Continuity to this shield is tested by connection *S* to V_1. A limited amount of electron flow from the cathodes to the shield occurs in a nondefective tube, so V_1 has a partial glow. The shorting of the shield to any other element is detected by a full glow of V_1 in the continuity-test operation.

This work was sponsored by the AMC, Wright Air Force Base, under technical direction of WADC.

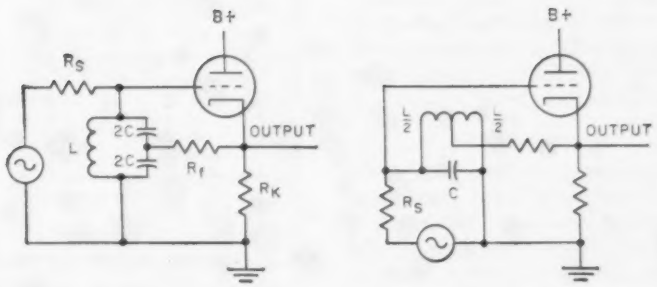


FIG. 1—Vacuum-tube Q-multiplier circuits use center-tapped coil or capacitor divider

Transistor Q-Multiplier for Audio Frequencies

High selectivity and stability may be provided in audio-frequency equipment that must be portable, or in which power is at a premium, by use of transistorized Q-multiplier circuit. Series-resonant circuit is applied to variable-selectivity a-f amplifier and multichannel selective-calling unit

By G. B. MILLER The British Thomson-Houston Co., Ltd., Rugby, England

POSITIVE FEEDBACK to increase the selectivity of a tuned circuit has been put to use on a sound engineering basis only in recent years. The literature gives all the design data for tube-operated Q-multipliers.[1] This article indicates what modifications must be made when transistors are used.

Theory

Figure 1 shows the basic Q-multiplier circuit for either a center-tapped capacitor or coil. The selectivity of this stage is determined by

$$Q_{eff}/Q_o = R_f/(R_f - \tfrac{1}{4}R_d) \qquad (1)$$

where Q_{eff} is the effective Q of the coil circuit, Q_o is the Q of the coil at the resonant frequency ω_o and $R_d = \omega_o L Q_o$. The effective Q, and thus the selectivity of the circuit, increases as R_f approaches $\frac{1}{4}$ R_d. When R_f equals $\frac{1}{4}$ R_d the effective Q becomes infinite and the amplifier is unstable; oscillations occur for all values of R_f less than $\frac{1}{4}$ R_d.

Equation 1 is valid only on the assumptions that the input impedance of the tube is infinite, the output impedance is negligibly small and $g_m R_k$ is much greater than unity.

Figure 2A shows the form taken by the circuit when a transistor replaces the tube. Resistors R_1 and R_2 provide bias to the base of the transistor and C_c prevents the bias from being shorted out by the coil. Since the input impedance to the transistor will not be infinite, Eq. 1 cannot be used as it is.

The value of R_d as used in Eq. 1 is the dynamic impedance of the parallel-tuned circuit at resonance and is purely resistive. The input resistance at XX in Fig. 2A, (with R_f and the tuned circuit disconnected is given by the following:

$$R_g = 1/(1/R_1 + 1/R_2 + 1/R_i) \qquad (2)$$

where $R_i = \beta R_k$, the input impedance of the grounded-collector transistor; β is the grounded-emitter current-amplification factor.

The circuit of Fig. 2A can then be replaced by that of Fig. 2B in which the transistor is considered ideal, with infinite input impedance, and L and C are pure reactances. Resistance R_g can be treated as a damping resistor which lowers the Q and reduces R_d to a lower value R'_d where

$$R'_d = R_g R_d/(R_g + R_d) \qquad (3)$$

Using R'_d in place of R_d in Eq. 1

$$\frac{Q_{eff}}{Q_o} = \frac{R_f}{R_f - \tfrac{1}{4}R'_d} \qquad (4)$$

Derivation of Eq. 4 is not dependent upon the transistor having infinite input impedance. Since the grounded collector stage also has

negligibly small output impedance and $g_m R_k >> 1$ is easily obtained, Eq. 4 can be used for the circuit of Fig. 2A. This equation may be used for circuits using either tubes or transistors.

Stability

The formulas derived with regard to the stability of tube-type Q multipliers all involve Q_o. The effect of the finite input impedance of the circuit using a transistor causes a reduction in the coil Q; this reduction must be taken into account in assessing the stability of the circuit.

The greater the Q multiplication required to achieve a specified selectivity, the lower the stability will be. For maximum stability the value of Q_o should be as high as possible; for a given coil this requires that R_g be large. Unfortunately, maintenance of the correct operating conditions with changes of temperature requires that R_g be as small as possible. The design must therefore be a compromise between these two conflicting requirements.

Temperature Effects

A change of temperature shifts the operating point of the transistor and causes a change in the current amplification factor β.

Normal methods of temperature stabilization cannot be used without seriously affecting the amount of stable Q multiplication which can be obtained. It has been found desirable to design the stage for the largest signal possible consistent with a minimum value of R_g. This minimum is easily derived from Eq. 3 and the stability requirement that $Q_{eff}/Q_o < \frac{1}{4} g_m R_k$. Since Q_{eff} is usually specified and $g_m R_k$ is known, Q_o can be calculated.

Let the Q of the coil used in the tuned circuit be $Q_o = R_d/\omega_o L$. When R_g is shunted across the coil the Q is reduced to $Q'_o = R'_d/\omega_o L$. Substituting for R_d and R'_d in Eq. 3 gives

$$R_{g\,min} = \omega_o L Q_o Q'_o/(Q_o - Q'_o) \quad (5)$$

If the transistor stage is designed for the largest signal possible consistent with the value of R_g given by Eq. 5 and then operated at a much lower signal level than it is designed for, a reasonable shift in operating point can take place without the transistor introducing distortion.

Referring to Eq. 2, R_g will be reasonably independent of R_t if $R_t >> R_1$ and R_2; this is the case for most transistors if R_k is kept reasonably high. The value of β decreases with increasing temperature and thus R_g will also decrease with temperature.

A reduction of R_g causes a reduction in R'_d and this reduces the ratio Q_{eff}/Q_o. An increase in temperature will not therefore lead to instability but will reduce the Q-multiplication obtained. If this reduction is unacceptable, it is necessary to allow R_f to decrease with temperature.

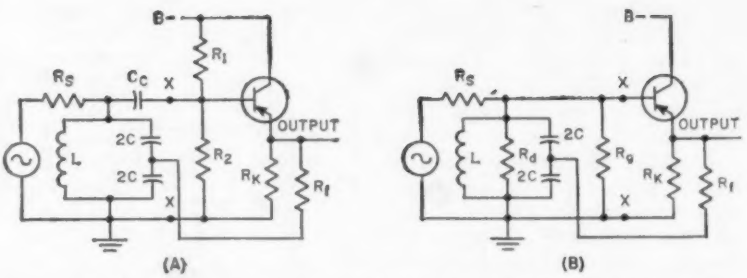


FIG. 2—Transistor equivalent of vacuum-tube version (A) and idealized circuit (B)

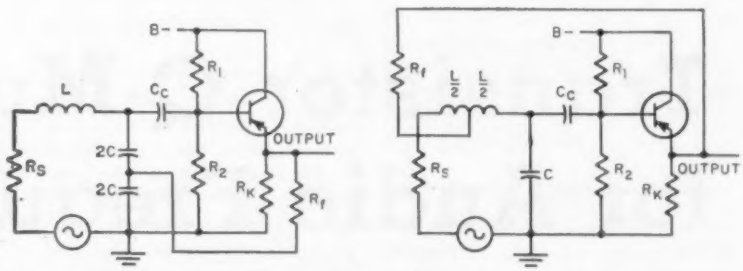


FIG. 3—Series-tuned circuits overcome shortcomings of parallel-tuned versions

Parallel Operation

When two or more selective amplifiers tuned to independent frequencies are to be operated from the same signal source, as in frequency-selective calling equipment, the parallel-tuned configuration shown in Fig. 2 is not suitable. Each tuned circuit tends to inject signals into the adjoining circuits, reducing adjacent channel rejection.

This difficulty has been overcome by the configuration shown in Fig. 3. The input is series-resonant, as seen from the signal source, and parallel-resonant, as seen by the input to the transistor. In this arrangement, each tuned circuit at its resonant frequency effectively shunts the input to all the other tuned circuits greatly reducing the breakthrough of signals.

Resistance R_s in Fig. 3 is the signal source resistance; it is ef-

Table 1—Conditions for Circuit Instability

Freq. (cps)	L (h)	C (μf)	R_L (ohms)	R_s (ohms)	$R_f = \frac{1}{2}R'_d$ (ohms x 1,000) Calc	Meas
				0	6.8	6.8
				82	6.6	6.6
190	6.8	0.1	840	180	6.45	6.3
				235	6.3	6.23
				500	5.7	5.63
				0	5.5	5.48
				82	5.23	5.15
216.5	4.5	0.12	790	180	5	4.85
				235	4.58	4.57
				500	4.25	4.2
				0	3.88	3.85
				82	3.73	3.68
235	3.8	0.12	1,255	180	3.62	3.6
				235	3.48	3.47
				500	3.12	3.1

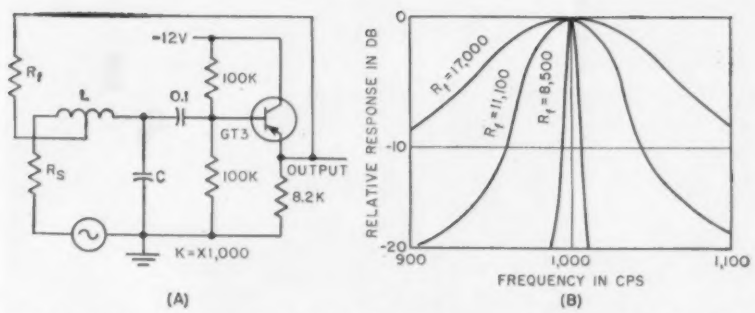


FIG. 4—Varying R_f of selective a-f amplifier (A) changes circuit Q-multiplication (B)

fectively in series with the coil and must be treated as part of the coil resistance when calculating the value of Q_o. Thus, $Q_o = \omega_o L/(R_s + R_L)$ where R_L is the resistance of the coil at the resonant frequency.

Practical Circuits

Figure 4A shows an audio-frequency selective circuit suitable for use either as a c-w note filter or as one channel in a multichannel frequency-selective amplifier.

When $R_f = \frac{1}{4} R'_s$, Eq. 4 shows that the circuit is unstable and will oscillate. The value of resistor R_f to give this condition were calculated for four different coils and for various values of generator resistance R_s. These calculated values were then compared with the actual measured values of R_f in the circuit for each condition and coil. The results, in Table I, indicate a close correlation between calculated and measured values.

The coils in Table I were built up into a three-channel a-f selective amplifier and connected as shown in Fig. 5A; Fig. 5B shows the response of each filter. The unit was driven from a generator with an impedance of 500 ohms. In comparison with a similar parallel-tuned unit, the adjacent channel rejection is much better.

With a minor modification, the circuit shown in Fig. 4A, can be used as a variable selective c-w filter; R_f should be replaced by a resistor and potentiometer in series. The resistor and potentiometer are each made equal to the minimum resistance needed for the maximum required selectivity.

This minimum value is calculated from Eq. 4, but if maximum possible selectivity is wanted, this value should be made equal to $\frac{1}{4} R'_s + 1$ percent. The 1-percent margin is usually sufficient to ensure that the circuit does not oscillate, but the value may have to be adjusted. The potentiometer acts as a selectivity control, with maximum selectivity corresponding to minimum potentiometer resistance; Fig. 4B shows a typical set of selectivity curves for various positions of the potentiometer.

The maximum Q-multiplication that can be achieved with the transistor Q-multipliers has not been fully determined. However, a Q of 1,000 at 200 cps was obtained without any difficulty using a coil with a Q of 10.

Factor R_t appearing in the expression for R_s covers a multitude of troubles, especially when the transistor circuit is to be used at frequencies approaching its cutoff frequency; for audio frequencies it is generally sufficient to treat R_t as being purely resistive, but at higher frequencies the complete expression must be used and account must be taken of the input capacitance.

Performance

An experimental parallel-tuned circuit set up for maximum selectivity at 200 kc gave an overall bandwidth of 300 cps; although it was completely stable against normal temperature and voltage fluctuations, it was possible to shock excite it into oscillation after which it would continue to oscillate. Tests indicate that it is possible to do this at all frequencies with both tube and transistor Q-multipliers; it is believed that this is due simply to driving the tube or transistor into a region of nonlinearity.

When the Q-multiplication is restricted to less than $\frac{1}{4} g_m R_s$ the shock excitation instability does not occur. If this restriction on the amount of multiplication is observed and, in addition, the input level is kept small enough to ensure that the transistor is not overloaded, trouble from this form of instability should not be experienced.

A temperature run was made on the unit shown in Fig. 4A with the temperature cycled from 20 to 60 C and back. Between 20 and 47 C, no measurable change in effective Q was detected, but from 47 to 60 there was a reduction of Q multiplication to $\frac{3}{4}$ of its initial value.

The resonant frequency of the filter was not affected when the transistor temperature was raised from 20 to 60 C.

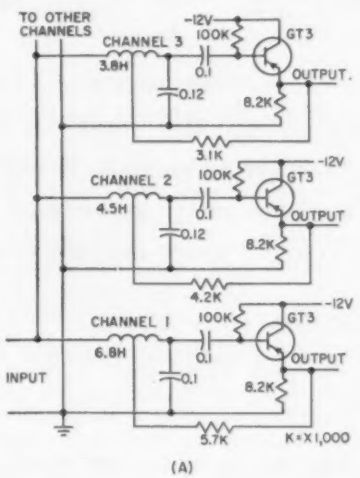
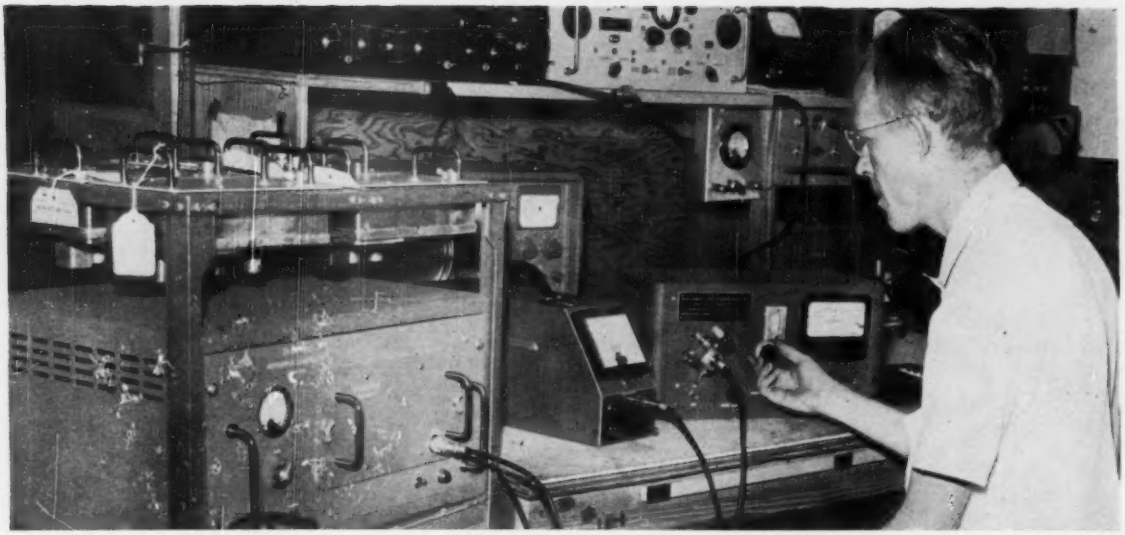


FIG. 5—Three channels of multichannel selective a-f amplifier (A) use coil and capacitor combinations in Table I for staggered resonant frequencies (B)

REFERENCE

(1) H. E. Harris, Simplified Q Multiplier, ELECTRONICS, p 130, May 1951.



Typical test setup for checking crystals. Crystal under test and cable of electronic null-indicating meter plugged into bridge unit are next to right hand of operator. Counter-type frequency meter at left reads r-f output frequency of crystal impedance meter into which bridge is plugged. With exception of frequency measuring unit, no auxiliary equipment is required

Plug-in Bridge Checks

Equivalent parameters of overtone crystals in range of 75 to 200 mc are rapidly measured with technique that combines desirable characteristics of both active and passive measuring systems. Bridge plugs into crystal socket of standard crystal impedance meter and crystal plugs into bridge. Null-indicating meter and frequency meter are only other instruments needed

By DOUGLAS W. ROBERTSON*

Research Engineer, Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Georgia

THE CRYSTAL PARAMETER bridge described here combines the characteristics of passive and active measuring systems for piezoelectric vibrators, by utilizing an oscillatory circuit and a bridge measurement configuration in such a way that the crystal being measured controls the frequency stability of the oscillator.

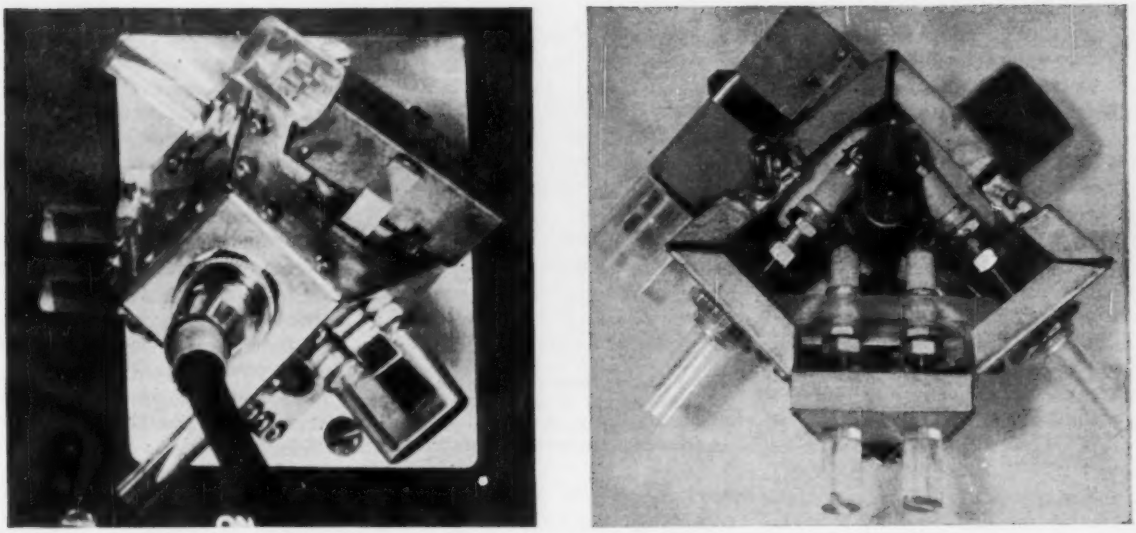
The bridge circuit, including the crystal under test, is inserted as a series element in the low-impedance feedback path of a self-controlled oscillator suitable for exciting a resonant frequency of a quartz crystal operating in the series mode. When the oscillator is tuned near or at one of the crystal resonant frequencies, it is stabilized by the increased portion of the feedback that passes through the crystal arm of the bridge. Therefore, the oscillator may be considered as supplying a crystal-stabilized signal for operation of the bridge near the resonant frequencies of the crystal.

Finding Equivalent Resistance

Operation of the crystal parameter bridge, shown schematically in Fig. 1, may be best understood when employed for the simple case of determining the equivalent resistance R_r of a crystal operating at resonant frequency f_r. Capacitors C_v and C_t are set equal near minimum capacitance or removed entirely from the circuit and all stray reactances are balanced or compensated. Resistor R_v contains no reactive components and R_a and R_b are passive impedances of any type but are matched in the frequency range of interest for equivalence in both magnitude and phase angle.

Resistor R_v is initially set to its minimum-resistance position and the oscillator is tuned until crystal control is effected. This point is shown by a sudden dip in the balance indicator reading and is the result of the change in degree of

*Now with Federal Telecommunication Laboratories, Atlanta, Georgia



Top and bottom views of plug-in bridge unit. Slotted clear plastic rods permit adjustment of variable resistor and capacitors in bridge. Crystal is at upper right, vhf resistor at upper left. C_2 and C_3 adjustments at bottom center and C_r and C_1 adjustments at lower left and right respectively in bottom view. Unit permits measurement of all equivalent circuit parameters of a quartz crystal

VHF Quartz Crystals

unbalance due to the lowered crystal impedance near resonance. Increasing R_r at this point decreases the minimum reading as the voltage drop across R_r approaches that across the crystal. Slight retuning of the oscillator will further decrease the minimum as the two voltages become more nearly equal. Repeating this process of alternately tuning the oscillator and R_r for a minimum reading will bring each successive dip closer to zero until the bridge is brought into balance and the vector voltage difference is zero. At this time, the crystal is operating at the minimum zero-reactance impedance which defines operation at the resonance frequency f_r. The resistance of R_r is equal to the equivalent resonance sistance R_r of the crystal and may be read directly if R_r is calibrated.

In a similar manner, the series arm resistance R_1 and the series resonant frequency f_s may be determined. This is accomplished by initially balancing the holder capacitance C_h with an equal capacitance C_r across R_r. If C_r is calibrated, the value of C_h may be determined directly from the dial.

In the vhf range, the most severe requirement of a practical bridge system is that imposed on the variable resistor R_r. This resistance must have near zero reactance over the frequency range of interest. Resistances exhibiting a satisfactory phase angle have been developed.[2] These resistors cover a frequency range of 75 to 300 mc and a resistance range of 20 to 200 ohms.

Determining Other Parameters

The following procedure for utilizing the bridge and companion oscillator of Fig. 1 can be used to determine the desired parameters. With R_r and the crystal removed from the bridge and with C_1 set close to minimum, balance with C_r as the variable at a frequency near the series-arm resonant frequency f_s; C_r will then equal C_1. Place the crystal in the bridge at a frequency adjacent to f_s such that the admittance of the series arm is insignificant when compared with that of C_h. Rebalance the bridge with C_r. Then ΔC_r equals C_h.

With R_r placed in the circuit, rebalance with R_r and frequency as variables. This yields f_r and $R_r = R_1$. Decrease C_r by ΔC_r and rebalance with R_r and frequency as variables. This gives f_r and $R_r = R_r$.

The measured parameters C_h, R_1, f_s and f_r are now substituted in the first equation for Q in Fig. 1, where the figure of merit M is equal to $1/\omega C_r R_1$ and Δf is equal to $f_r - f_s$. Although this equation is double-valued, the correct value is obtained by using the negative sign. With this, values of L_1 and C_1 are now readily obtained from the other two equations for Q in Fig. 1.

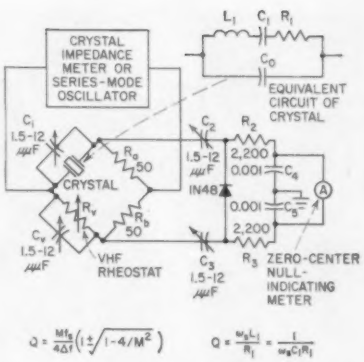
Construction Details

Several developmental models of the crystal parameter bridge have been made. These models, containing suitable detectors, are constructed as small self-contained units capable of being plugged into the crystal socket of a suitable crystal impedance meter oscillator. The pyramidal shape of the bridge resulted from an attempt to eliminate cross-coupling by arranging all of the components to be nearly per-

pendicular within the limits set by size, accessibility and lead length.

Capacitors C_2 and C_3 couple the unbalance output of the bridge to the germanium diode detector. Since these capacitors must be accurately balanced they are made variable. The required detector load and filter are provided by R_2, R_3, C_4, C_5 and the null indicator input impedance.

The rectified output of the detector is fed by cable to a sensitive null indicator. The physical separation of the bridge and oscillator allows use of the bridge with different oscillators.



$$Q = \frac{Mf_0}{4\Delta f}\left(1 \pm \sqrt{1 - 4/M^2}\right) \qquad Q = \frac{\omega_0 L_1}{R_1} = \frac{1}{\omega_0 C_1 R_1}$$

FIG. 1—Bridge circuit and equations used with test results to give desired parameters. Bridge plugs into crystal socket of impedance meter or oscillator

Crystal Impedance Meter

The possibility of using the tube transit time and detuning to obtain proper loop phase led to the construction of the developmental crystal impedance meter circuit of Fig. 2.

Used primarily for a substitution system in the very-high-frequency range, this unit covers a frequency range of 75 to 200 mc for equivalent crystal resistances up to 200 ohms. Two stages of amplification are used to increase the loop gain. Two difficulties associated with the practical realization of the circuit configuration are proper tracking of the tuned circuits and the additional 180 deg phase shift normally attributed to the addition of a second amplifier.

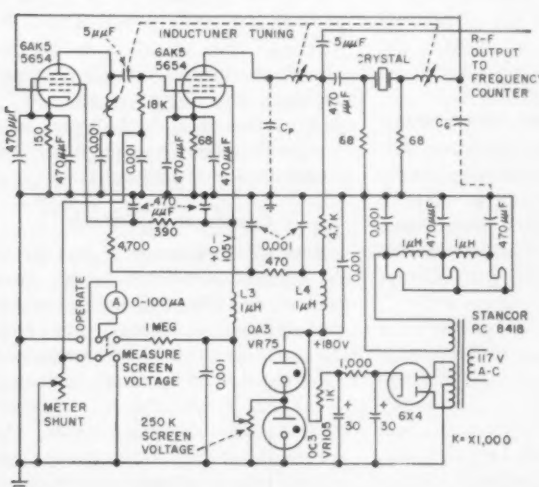
A novel method was utilized to eliminate the tunable interstage transformer required to compensate for the additional 180-deg phase shift. Data on the magnitude of transit time phase shifts indicate that the 6AK5 exhibits a phase shift of approximately 0.3 deg per mc. At 150 mc the total transit time phase shift for both tubes will therefore be near 90 deg. It is then immaterial whether or not a phase reversal is provided by the interstage transformer, as equal detuning would be required in either case to give zero loop phase shift. This characteristic permitted a simple resonant coil to be substituted for the tunable interstage transformer.

The oscillator uses a three-gang Mallory spiral Inductuner for the variable inductances. The tuner was modified by removing the last turn of the central spiral section. This modification provides the correct interstage inductance to track satisfactorily with the other two sections.

With the exception of the related power and control circuits, the circuitry and components are mounted on the modified tuner enclosure itself. To minimize ground-lead r-f currents, the center posts of the tube sockets are connected directly to the tuner ground plane and these two points are used as central ground points where possible.

The successful operation of the two-stage line-coupled oscillator with its high gain is dependent to a large extent upon the physical arrangement of the components. This arrangement permits extremely short leads and proper shielding or isolation by the various sections of the circuit. Small disk ceramic capacitors were connected directly from the tube-socket terminals to the center post ground point for bypass purposes. All power and control leads are bypassed at the tuner enclosure with ceramic feed-through capacitors, which serve as mounts for the various decoupling resistors and chokes.

The power supply converts the 115-v a-c to the required d-c plate and screen voltages. These d-c voltages are regulated by two voltage regulator tubes. An external control is provided for adjustment of the screen voltage as a method of controlling the drive or power



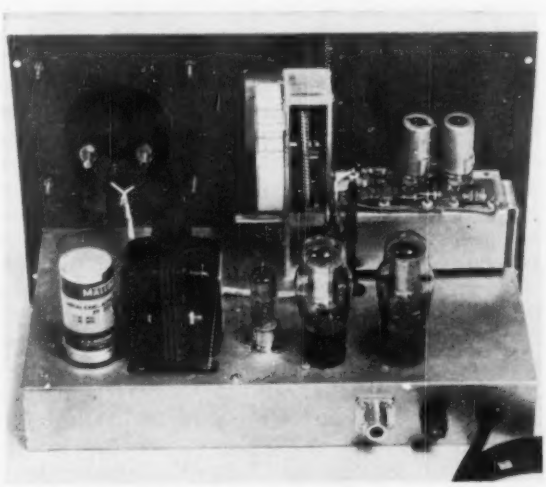


FIG. 2—Circuit of development crystal impedance meter, which may be used conventionally with test crystal in position shown, or in new method by inserting bridge in place of crystal. Rear view of instrument is shown alongside circuit

dissipated in the crystal. The frequency of the oscillator is varied by tuning through a suitable gear reduction to provide the necessary vernier adjustment. A sensitive d-c meter is provided, with a variable shunt, to indicate relative activity at high as well as at low drives. A coaxial jack provides a sample of the r-f energy for frequency-measuring purposes. The entire unit is encased in a steel cabinet for shielding and protective purposes.

Checking Accuracy

Because precise standards for measuring crystal parameters above 100 mc are presently unavailable, the probable accuracy of the bridge method was determined on a comparative basis. Measurements on a number of representative crystals covering a frequency range of 100 to 175 mc and a resistance range of 20 to 120 ohms were made independently with several different substitution methods. These crystals were then measured with the crystal parameter bridge and developmental oscillator. The crystal parameter bridge measurements were then compared to the substitution measurements which in each case displayed the greatest deviation from the bridge measurements. The parameters compared were the resonance resistance R_r, the resonance frequency f_r, the series resonance resistance R_1 and the series resonance frequency f_s.

Of a total of 26 frequency measurements, 20 were at or within 0.001 percent, 4 were between 0.001 percent and 0.002 percent and 2 were above 0.002 percent, the highest deviation being 0.0031 percent. Sixteen of these measurements were at frequencies above 150 mc.

Of a total of 26 resistance measurements, 21 were within 5 ohms or 10 percent, 4 were between 10 and 20 percent, and one displayed a difference of approximately 30 percent (175 mc at 100 ohms). Twelve of these were above 50 ohms.

Considering that the crystal drive or power could not be accurately determined or reproduced and that the comparisons were made to those having the largest discrepancy, the deviations experienced were not unexpected. However, the results did indicate that the measurement accuracy of the bridge was comparable to that obtained by other active methods.

Crystal Aging Measurements

Although the crystal parameter bridge was developed primarily for use at frequencies above 75 mc, its effectiveness at lower frequencies was adequately demonstrated when used in connection with a crystal aging program being conducted at Georgia Institute of Technology. The aging drifts under study were obscured by the inaccuracies and randomness of the frequency measurements made with conventional susbtitution measurement procedures.

The crystal parameter bridge measurements, consistently accurate to one part in 10^7 at 16 mc, matched the quality of the resonators being produced and made possible studies of previously concealed factors in the aging of quartz crystal resonators. A typical aging curve obtained with the bridge system is compared in Fig. 3 with one obtained by the substitution method.

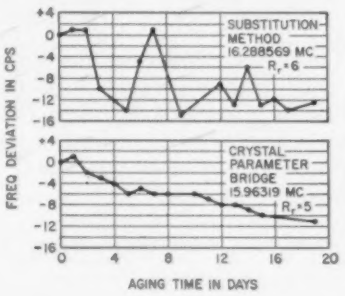


FIG. 3—Comparison of results obtained with older substitution method and new crystal parameter bridge method, when checking aging of crystals. High accuracy of new method gives smoother curve more nearly representative of true behavior of crystal

Because of the number of repeated measurements necessary on a large number of crystals, an additional advantage was realized in the rapidity and simplicity of bridge measurements. A reduction in measurement time from approximately 5 minutes to less than 2 minutes per crystal was obtained.

Although efforts were made to develop a practical system using the bridge method that would measure crystals up to 200mc at 200 ohms, the present models have definite limitations. Primarily, the crystal parameter bridge in its present state of development is a lumped-element bridge and, as in conventional bridges, such construction is generally unsatisfactory above 150 mc.

Another limitation that occurs above 150 mc is due to the crystal holder capacitance C_s and its associated bridge balancing capacitance C_v. As the frequency is increased the reactances of the feedback paths due to C_s and C_v become lower. This, in effect, decreases the proportional amount of crystal-controlled feedback and satisfactory stabilization of the oscillator is not obtained.

A third major limitation is that the commonly accepted equivalent circuit no longer adequately represents present vhf crystal units. The holder appears to cause the primary difficulty in that it contributes reactances and resistances at the higher frequencies that can no longer be neglected. The complexity of the equivalent circuit is, therefore, greatly increased.

Several methods of overcoming these practical limitations are presently being investigated. A hybrid coaxial bridge using balanced directional couplers is being developed to eliminate some of the difficulties of a lumped element arrangement. A method of counteracting the feedback due to C_s and C_v with a plan similar to that used in capacitance bridge oscillators is under study.

The development reported herein was supported by the SCEL under Contract No. DA-36-039-sc-56730. Reproduction in whole or in part is permitted for any purpose of the U. S. Government.

References

(1) E. A. Gerber, A Review of Methods for Measuring the Constants of Piezoelectric Vibrators, *Proc IRE*, p 1,103, Sept 1953.

(2) Standards on Piezoelectric Vibrator, *Proc IRE*, p 353, Mar 1957.

(3) W. B. Wrigley and T. R. Scott, Jr., VHF Rheostat, ELECTRONICS, p 196, Dec 1, 1957.

(4) R. B. Belser, Study of the Effects of Processing Techniques and Materials on Aging of Quartz Crystal Units, Quarterly Report No. 6, Project A-226, Georgia Institute of Technology, Signal Corps Contract DA-36-039-sc-64613.

Phase-Shift Curves

Curves permit quick determination of unknowns in phase, gain and frequency interrelationship in lead and lag networks for feedback amplifiers. Component values can then be selected by choosing one of three values

By **RICHARD E. ENGELMANN**
Associate Professor of Electrical Engineering, University of Cincinnati, Cincinnati, Ohio

LEAD AND LAG NETWORKS of the type shown in Fig. 1A and 1B are commonly used for compensation in feedback amplifiers. The attenuation characteristics of these networks are shown in Fig. 1C using straightline approximation for convenience.

The maximum phase shift obtainable from these networks is a function of gain (<1) of the lead network at low frequencies and of the lag network at high frequencies. The following method can be used for determining the amount of shift available for a given attenuation or vice versa and the frequency at which this shift occurs.

For the lead network in Fig. 1, the transfer function is:

$$E_o/E_i = \alpha_1[(1+j(\omega/\omega_{c1})]/[1+j\alpha_1(\omega/\omega_{c1})]$$

where $\alpha_1 = R_2/(R_1 + R_2)$, which is the low-frequency gain; $\omega_{c1} = 1/R_1C_1$, which is the lower corner frequency in radians per sec and ω_{c1}/α_1 is upper corner frequency in radians per sec.

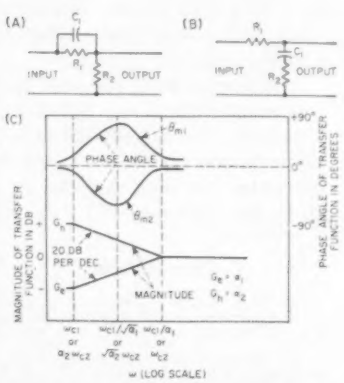


FIG. 1—Lead and lag networks at (A) and (B) result in gains shown at bottom of C and phase angles shown at top of (C)

The maximum phase shift is given by:

$$\phi_{m1} = \tan^{-1}(1/\sqrt{\alpha_1}) - \tan^{-1}\sqrt{\alpha_1}$$

and occurs at the geometric mean of the corner frequencies, so that $\omega/\omega_{c1} = 1/\sqrt{\alpha_1}$. Figure 2 shows ϕ_{m1} and corresponding values of ω/ω_{c1} compared to α_1.

For the lag network shown in Fig. 1B, the transfer function is:

$$E_o/E_i = [1+j(\omega/\omega_{c2})]/[1+j(\omega/\alpha_2\omega_{c2})]$$

where $\alpha_2 = R_2/(R_1 + R_2)$, which is the high frequency gain; $\omega_{c2} = 1/R_2C_2$, which is the upper corner frequency in radians per sec and $\alpha_2\omega_{c2}$ is the lower corner frequency in radians per sec.

The maximum phase shift, ϕ_{m2}, is given by $\phi_{m2} = -\phi_{m1}$ if α_2 is substituted for α_1. Therefore the maximum phase shift curve in Fig. 2 is correct. ϕ_{m2} occurs again at the geometric mean of the corner frequencies, where $\omega = \omega_{c2}\sqrt{\alpha_2}$ or $\omega/\alpha_2\omega_{c2} = 1/\sqrt{\alpha_2}$. Since the ratio of the frequency for maximum phase shift to the lower corner frequency is $1/\sqrt{\alpha}$ for both networks, the second curve of Fig. 2 is correct also.

Examples

Assume that a network is required to produce a phase lead of 50 deg at 600 cps. How much gain will result and what components can be used?

At $\phi_m = 50$ deg on the maximum phase shift curve, $\alpha_1 = 0.135$. With $\alpha_1 = 0.135$, on the second curve $\omega/\omega_{c1} = 2.7$. Substituting, $\omega_{c1} = 2\pi 600/2.7$, which equals $1/R_1C_1$, and $\alpha_1 = 0.135 = R_2/(R_1 + R_2)$ one variable can be selected and the others determined. If $C_1 = 1\ \mu$f, then $R_1 = 716$ ohms and $R_2 = 112$ ohms.

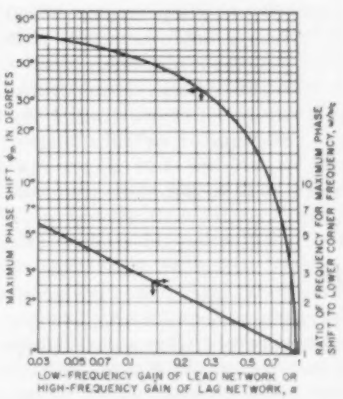

MAXIMUM PHASE SHIFT ϕ_m IN DEGREES
RATIO OF FREQUENCY FOR MAXIMUM PHASE SHIFT TO LOWER CORNER FREQUENCY, ω/ω_{c1}
LOW-FREQUENCY GAIN OF LEAD NETWORK OR HIGH-FREQUENCY GAIN OF LAG NETWORK, α

FIG. 2—Relationship of phase shift to gain enables user to determine ω/ω_c

If a lag network is required to have a phase shift of 60 deg and gain of 0.1 or more at high frequencies, is a network of the type shown in Fig. 1B possible?

From the curves, a phase shift of 60 deg will produce a gain of 0.071. Therefore the desired network is not possible. However, if two networks are used each with a phase shift of 30 deg and isolated by a buffer stage, the effective gain of the networks will be 0.109. A cathode follower could be used for the stage between the networks.

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Transistor H-F Cutoff Nomograph

When either alpha cutoff frequency f_α or maximum oscillation frequency f_{max} are specified, chart permits easy conversion from one to the other. With value of f_{max} known, maximum power gain at any frequency can be found

By H. E. SCHAUWECKER Gilfillan Bros. Inc., Los Angeles, California

TRANSISTOR ALPHA CUTOFF frequency which results from the finite diffusion time of charge carriers through the base region is one of two characteristics that limit high-frequency performance. The frequency characteristic of alpha is represented approximately by

$$\alpha = \alpha_o/(1 + j\omega/\omega_\alpha)$$

Collector capacitance C_c, the capacitance across the collector to base junction, also limits the maximum frequency of operation.

For most transistors, alpha is approximately equal to unity and maximum oscillating frequency is approximated by

$$f_{max} = (f\alpha/25.1R_BC_c)^{1/2}$$

or in terms of f_α

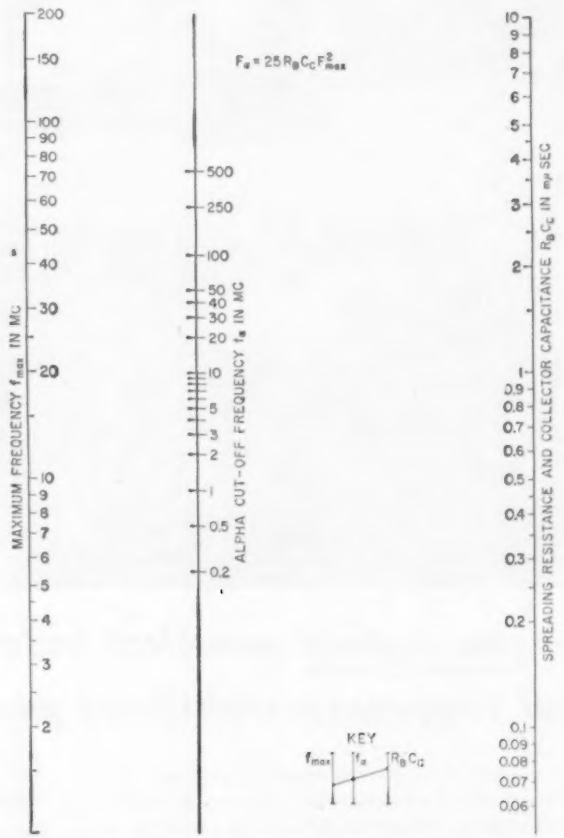
$$f\alpha = 25R_bC_c(f_{max})^2$$

Since some manufacturers specify $f\alpha$ and others f_{max}, conversion from one to the other is desirable.

Practical Examples

When f_α is 20 mc, R_B is 40 ohms and C_c is 10 $\mu\mu f$, f_{max} is desired. A straight line is drawn between the two points f_α = 20 mc and $R_B C_c$ = 400 $\mu\mu$sec, or 0.4 millimicroseconds. The value for f_{max} is read from the left-hand scale as 44 mc.

A transistor with an f_{max} of 10 mc and an $R_B C_c$ product of 2,000 $\mu\mu$sec or 2 mμsec is available. It is desired to determine the beta cutoff frequency for this transistor for which f_α is required. Referring to the nomogram, a straight line is drawn through f_{max} = 10 mc and $R_B C_c$ = 2 mμsec. The line intersects the center scale at f_α = 5 mc.



Nomograph for converting transistor high-frequency parameters

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All of SLIPKNOT #7 PLASTIC ELECTRICAL TAPE'S properties so far exceed previous specifications for vinyl electrical tape that it is truly felt to be revolutionary in the field. It is available from stock at your distributor's in ¾" width, and can be had on special order in any width. It carries the UL label, of course. This new tape has successfully passed the most rugged laboratory and field tests ever devised. It will pass all of yours, too. Here are some of the specifications:

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Tensile Strength	25 lbs./ inch width	Power Factor at 60 Cycles	.07
Elongation At Break	150% minimum	Power Factor at 10^6 Cycles	.03
Adhesion to Highly Polished Surface	30 oz./ inch width	Dielectric Constant at 60 Cycles	3.2
Adhesion to Backing	28 oz./ inch width	Dielectric Constant at 10^6 Cycles	2.3
Transfer of Adhesive	None	Insulation Resistance	500,000 Megohms
Moisture Vapor Transmission	2.5 gms./ 100 sq. in/ 24 hours	Electrolytic Corrosion Factor	1.0

Data given represents averages and should not be taken as maximum or minimum for specification purposes.

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Crt Images Persist for Days

CATHODE-RAY oscilloscopes are characterized by the disadvantage of relatively short persistence. Evaluation of transient phenomena is difficult because of the short time that curves remain legible.

Toward the end of WW II, use was made of blue-writing oscilloscopes. But these fell into commercial insignificance in the post-war years. German engineers dug out old files and began production of a blue-writing crt. It is to be incorporated into the design of a blue-writing oscilloscope marketed by Wandel & Goltermann, of Reutlingen, Germany.

The rectangular front screen of the tube is backed by a mica screen coated on its inner side with a layer of potassium chloride. The front surface of the mica is covered with a transparent current-conductive erase coating provided with terminals for connection to a source of power.

As the beam of electrons generated by the electron gun wanders across the screen, it will leave a violet-blue trace because of the potassium chloride changing color under the influence of the electrons. The trace will remain legible on the screen for hours and days, it is claimed. It can be erased at will by passing current through the transparent layer deposited on the mica screen.

The recorder unit has a built-in deflection amplifier (frequency from zero to 10 kc) to give deflection factors up to 3.3×10^5 mv per cm. Sweep time can be varied between 0.01 and 3 seconds. The useful recording speed is some 1,280 feet per second in ten lines spaced 5/16 inch apart.

The time required to erase the complete image screen is about 30 seconds; single lines can be individually erased one after the other so that continuous recordings can be made.

Image definition is said to be sharp enough to permit photographic records to be made.

Technique Finds Tube Resonances

By R. B. TATGE
Mechanical Engineering Lab.
General Electric Co.
Schenectady, N. Y.

VACUUM TUBES are often required to operate in environments having high vibration levels. This can lead to two types of malfunction, which may occur singly or together.

The first is generation of spurious signals (microphonics) because of relative motion between the vacuum tube electrodes. The support structures in the tube (particularly mica spacers) loosen more as the tube elements vibrate. Thus electrode movement increases with the same level of vibration as the tube ages.

The second type of malfunction is physical damage to the tube, such as cracking of the envelope or loss of oxide from the cathode. Such failures may occur with little or no warning.

These factors make it desirable to choose tubes whose electrodes have low mobility and whose resonances do not coincide with vibration frequencies in the tube's socket and mounting structure.

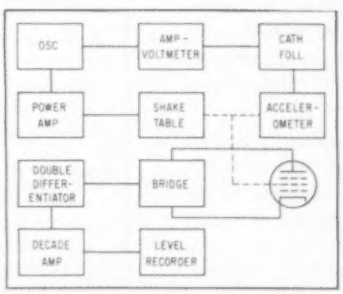

FIG. 1—Accelerometer is used as a sensing device to maintain constant acceleration of shake table as it is swept in frequency

A direct measurement of the response of a vacuum tube electrode to a given forcing function applied to the completed tube would be difficult, perhaps involving x-ray microscopy. An indirect measurement technique has been developed using commercially available equipment. Relative response of an electrode as a function of the applied frequency can be readily measured.

Using this technique, the tube is rigidly mounted on a shake table whose acceleration is held constant as frequency is swept. A feedback loop is used with an accelerometer on the table used as the sensor. The tube filament is heated by a battery to minimize hum pick-up.

A capacitance bridge, connected to two tube elements, is balanced with the shake table excitation off. At this time, the bridge sees a capacitance, C_o, which is the sum of the tube interelectrode capacitance and the cable capacitance (which is fixed). When the table is shaken, the tube elements vibrate, and the capacitance seen by the bridge may be expressed as

$$C = C_o + \Delta C \sin\omega t$$

where ΔC is the peak change in capacitance due to electrode displacement and ω is the angular frequency applied to the shake table. The bridge output is an a-c signal proportional to ΔC.

Since the object is to locate resonances in the tube structure, it is desirable that, in the absence of resonances, the bridge output be constant over the frequency range. Since shake table acceleration is

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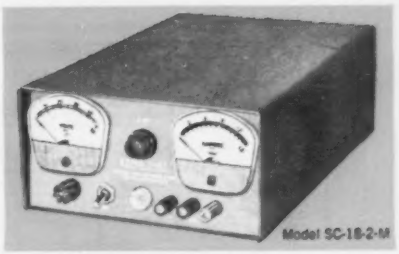

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SC-18-1	0-18	0-1	.02	.2	8⅛"	4⅛"	13⅜"	250.00
SC-18-2	0-18	0-2	.01	.1	8⅛"	4⅛"	13⅜"	295.00
SC-18-4	0-18	0-4	.005	.05	19"	3½"	13"	395.00
SC-36-0.2	0-36	0-0.2	.1	1.0	8⅛"	4⅛"	13⅜"	275.00
SC-1836-0.5	18-36	0-0.5	.08	.8	8⅛"	4⅛"	13⅜"	250.00
SC-1836-1	18-36	0-1	.04	.4	8⅛"	4⅛"	13⅜"	295.00
SC-1836-2	18-36	0-2	.02	.2	19"	3½"	13"	395.00
SC-3672-0.5	36-72	0-0.5	.15	1.0	8⅛"	4⅛"	13⅜"	295.00
SC-3672-1	36-72	0-1	.08	.8	19"	3½"	13"	395.00

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- **RECOVERY TIME** 50 microseconds
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- **TEMPERATURE COEFFICIENT** 0.05% per °C. Ambient operating temperature 50°C maximum. Over-temperature protection included. Unit turns off when over-temperature occurs.
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- Units can be series connected.
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Units without meters use model numbers indicated in table. To include meters add M to the Model No. (e.g. SC-18-1-M) and add $30.00 to price.

*Rack adapter for mounting any two 8⅛" x 4⅛" units is available. Model No. RA2 is 5¼"h x 19"w, is $15.00

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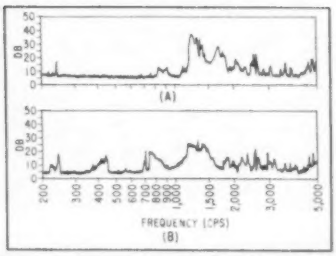

FIG. 2—Comparison of recordings with capacitance bridge between cathode and plate (A) and between cathode and screen grid (B) indicate frequencies at which cathode vibrates

held constant, while the bridge senses displacement, this may be achieved by differentiating the bridge output twice to get a new signal proportional to the tube element acceleration. This signal is plotted on a high-speed level recorder which is synchronized with the sweep oscillator.

The process is repeated using one of the same tube elements and one other element. A comparison of the two plots discloses which of the resonances are common to both plots, and, therefore, caused by vibration of the tube element common to both tests.

A disadvantage of this technique is the difficulty in determining absolute response. In addition, output of the capacitance bridge is a function of mode shape as well as peak electrode displacement. For many applications, these considerations are secondary to the speed and ease of analysis offered.

Feedback Stabilizes Flip-Flop

By PHILIP CHEILIK

Federal Telecommunication Laboratories, International Telephone and Telegraph, Nutley, N. J.

FEEDBACK enables a transistorized flip-flop to operate on pulses of 3 volts with 0.5 microsecond fall time. The flip-flop is very independent of changes in voltage and unbalance of transistors. The circuit was designed for use in a computer.

Operation

The common emitter resistor R_e in Fig. 1 provides d-c degeneration. For good trigger sensitivity, it is heavily bypassed in order to increase the gain around the regenerative loop. Resistor R_f connected between the bases of the two transistors provides negative feedback.

Assume that Q_1 is conducting and Q_2 is cutoff. A negative pulse is applied at the base of Q_1 cutting it off. Its collector rises to +11 v, and the rise is coupled to base B_2 through the cross-coupling network. As B_2 rises above B_1, a current flows in feedback resistor R_f. This current reduces the normal base current of Q_2 and prevents B_2 from rising too high. Base B_2, in turn, regulates the collector current drawn by transistor Q_2.

The flip-flop uses emitter followers in the cross-coupling network in order to match the high collector output impedance to the low base input impedance. These emitter followers also serve as low impedance output coupling to drive gating chains.

In the computer, the flip-flop is triggered with the differentiated trailing edge of a logic pulse to avoid the use of interstage delays for such circuits as shift registers. Capacitor coupling with a large time constant is used in case the logic pulse has poor fall time.

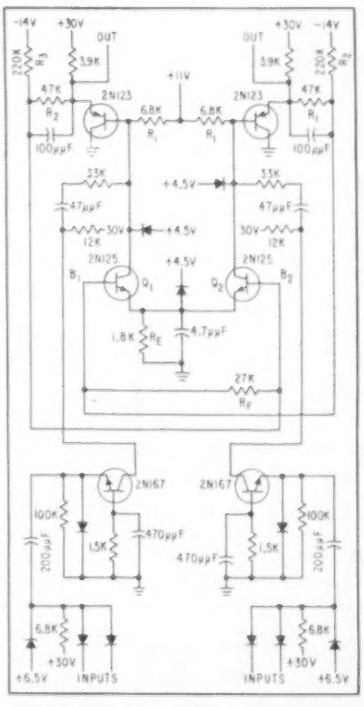

FIG. 1—Feedback resistor R_f in flip-flop makes it less sensitive to voltage variations and transistor unbalance

Attenuation is small even for slow fall time. The partially differentiated pulse is amplified, and the output of the amplifier is differentiated. Since phase reversal is undesirable, a grounded-base *npn* transistor provides a negative pulse to bring the amplifier into conduction from its normally cutoff state.

Design

For values of β between 20 and 100, transistors 2N124, 125, 126 and 167 may be used. The voltage swing required is six volts from +5 to +11. A self-biased multivibrator is used to improve d-c stability.

For a 2N125 at an ambient temperature of 55 C, 28.5 mw is maximum dissipation. With a collector current of about 1 ma for a transistor of minimum β, a 6,000-ohm resistor is needed for R_1 in order to get a 6-volt swing. A 6,800-ohm resistor, the nearest standard 10-percent value, is used.

When R_f is considered disconnected, 50 μa of base current is needed where $I_e = 1$ ma and $\beta = 20$. If the cross-coupling resistors are large compared to R_1, the equivalent Thevenin resistance $R = (R_2 + R_3)/R_2R_3$. When $R = 50{,}000$ ohms, the base input resistance of a transistor is very low in comparison. The drop across the base-to-emitter junction can be ignored, and the total drop can be assumed to occur across R. For $I_b = 50$ μa, a positive voltage swing of 2.5 v across R is required. For a symmetrical peak-to-peak signal of 5 v at the base, the collector swing is 6 v so that $a = R_3/(R_2 + R_3) = 5/6$. Emitter follower gain is assumed to be one. Since R equals 50,000 ohms, R_2 and R_3 will be 60,000 and 300,000 ohms, respectively.

To obtain a base current margin, somewhat smaller resistors in the same ratio are used. Convenient values are $R_2 = 47{,}000$ and $R_3 = 220{,}000$ ohms.

When Q_2 conducts, $V_{c2} = 5$ v and $V_{b1} = 5/6 \times 19 - 14 = 1.8$ v. R_e must be large enough so that the voltage drop across it exceeds the 1.8 v necessary to cut Q_1 off. When $\beta = 20$, the base of Q_2 is at $(11 + 14) \times 5/6 - 14 = 6.8$ v.

Since $(V_{b2} - \beta I_{b2} R_e)/R = I_{b2}$,

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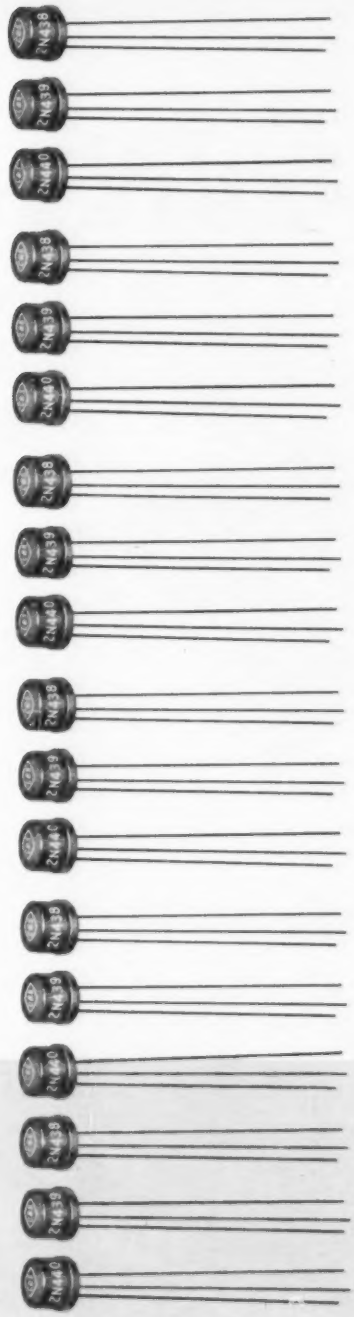
All three types are alloy-junction for greater uniformity, higher voltage and current, flatter gain and lower saturation resistance. They employ the standard JETEC TO-9 package welded to achieve reliability never before approached with NPN transistors.

Note the many desirable features. You may be able to use these CBS transistors. Write for Bulletin E-268 giving complete data and helpful application notes.



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Wire types:	enamel, silk, cotton, Teflon, sleeve covered, filar
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$I_{b_2} = 89.5$ μa and $I_{c_2} = 1.79$ ma.

For $\beta = 100$, the same procedure is used. However, since a clamp is present $\beta I_b R_e$ will represent the drop across R_e only if it is less than 5.

If V_e is assumed to be less than 5 v, the formula indicates that $I_{b_2} = 31$ μa. Checking, $\beta I_b R_e = 180{,}000 \times 31$ μa $= 5.38$ v. Therefore, the drop is not completely across R_e. Substituting 5 for $\beta I_b R_e$, $I_{b_2} = 45$ μa. Collector current I_{c_2} is therefore 4.5 ma.

The dissipation, $V_{c_2} I_c = 22.5$ mw, is within the allowable rating at 55 C.

Checking for stability for $\beta = 100$, $\alpha = 0.99$. $S = (R_e + R_b)/[R_e + R_b (1 - \alpha)]$ or 19.

The maximum I_{co} for any of the transistors previously mentioned is 2 μa. The stability against runaway is a function of S and of I_{co}. The maximum allowable dissipation of 23 mw is not exceeded for any value of β previously indicated. Clamp diodes used at the emitters and the collectors to prevent the transistors from saturating, speed the operation. The collector diode also serves to fix the lower level of the voltage swing.

The large emitter capacitor acts somewhat like a bias battery in conjunction with the emitter resistor. The cross-coupling capacitors were chosen so that the cross-coupling time constant is larger than the expected rise time but smaller than the period.

Assuming the base input resistance is small, the time constant is given by $R_1 C_e = 6{,}800 \times 100$ μμf $= 0.68$ μs.

The feedback resistor was picked experimentally. It is possible to analyze the circuit with the feedback resistor, to determine the operation with the chosen value of 27,000 ohms.

The effect of the feedback resistor R_f is that collector current varies by a smaller ratio, 2.08/1.08 or 1.93 as compared to 4.5/1.79 or 2.52. Also, the total collector current is much smaller so operation is within the maximum dissipation rating.

V_e never goes above 5 v so the diode at the emitter can be eliminated. Without the feedback resistor, it takes 2.5 to 4.5 volts to

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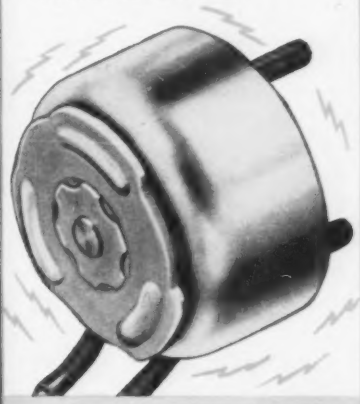

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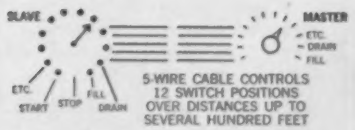

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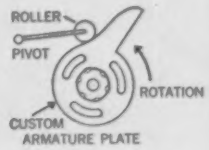

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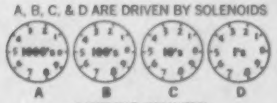

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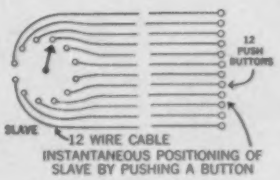
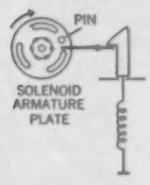
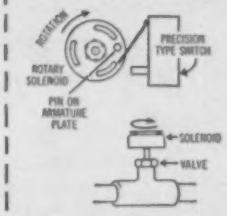


12 WIRE CABLE
INSTANTANEOUS POSITIONING OF SLAVE BY PUSHING A BUTTON

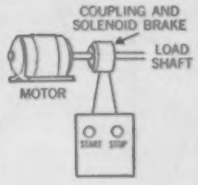
AUTOMATIC SWITCHING



TRIPPING DEVICES



ACTUATORS



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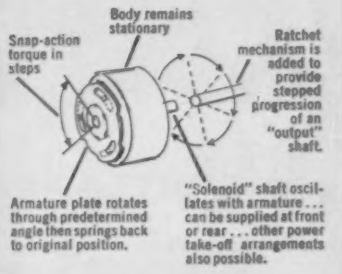
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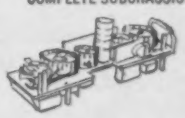

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trigger the flip-flop, while with feedback, the range of voltage necessary is from 1.5 to 2 volts.

Phase Shifter Range Exceeds 180°

By W. G. SHEPARD
Physical Research Staff, Boeing Airplane Co., Seattle, Washington

PHASE-SHIFTING circuits with ranges greater than 180 degrees are often useful.

The circuit shown in Fig. 1A is often used to shift phase. With perfect circuit components, with the resistance variable to infinity and

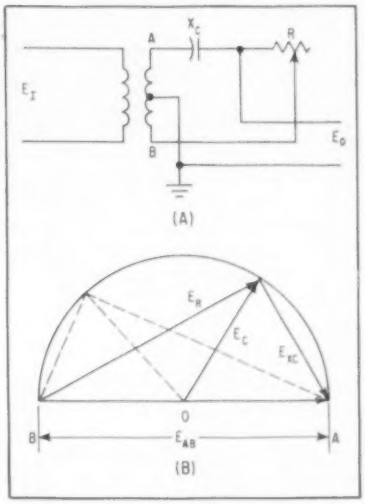

FIG. 1—Constant output voltage is produced by simple phase-shifting circuit with a theoretical range of 180 degrees

with no load, a 180-degree phase-shift range is theoretically possible.

A vector diagram, Fig. 1B, may be constructed for this circuit by noting that the voltages across X_c and R are always 90 degrees out of phase and that the addition of these vectors always equals E_{AB}, the voltage across the transformer secondary. The locus of all intersections of E_{Xc} and E_R, forms a half circle. The output voltage will be constant for any value of R.

A circuit giving similar results uses an inductor instead of a capacitor. Often the resistance is fixed and a saturable reactor used as the variable element. The saturable reactor may be controlled by a

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650 mc

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Model MSG-34
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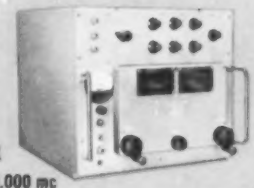

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Model SSX-A *
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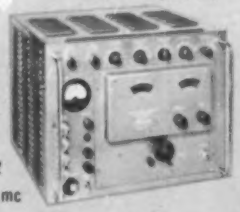

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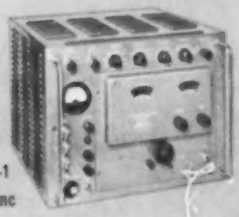

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- 7 plug-in r-f tuning units and a basic unit cover the frequency range from 18,000 to 39,700 mc.
- Direct-reading calibrated output attenuator, accuracy ± 2 db.
- Frequency calibration accomplished by a ± 0.1% direct-reading wavemeter.
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12,400 mc
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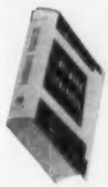

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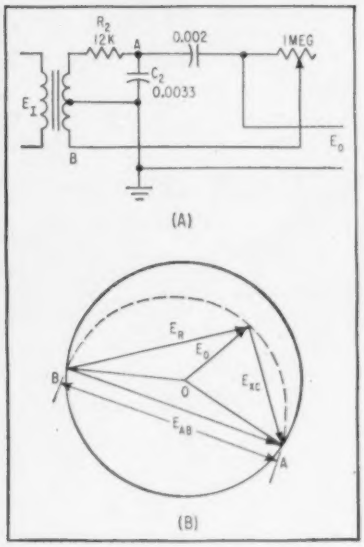

FIG. 2—Phase of output voltage can be varied more than 180 degrees but output voltage is not constant

vacuum tube or transistor, allowing automatic control.

In the practical case, 180-degree range is not possible with the circuit shown in Fig. 1A.

One way to achieve 180-degree or more phase shift is to have greater than 180 degrees between points *A* and *B*. Fig. 2A shows a circuit in which the phase at point *A* is made to lag by an R-C combination (R_2C_2). This circuit has about 190-degree phase range at one kc.

To satisfy the right-angle condition for E_{EC} and E_B, the locus

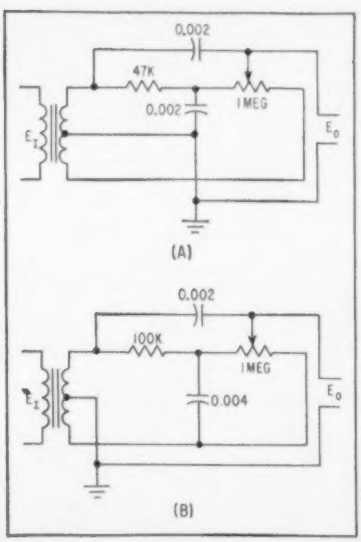

FIG. 3—Output voltage for these circuits is more nearly constant

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Mr. Emmanuel A. Blasi, right, Manager of Antenna and Propagation Department, discusses results of radiation performance after antenna pattern measurements with staff scientist Allen S. Dunbar. Column bearing missile in background is operated automatically from laboratory.

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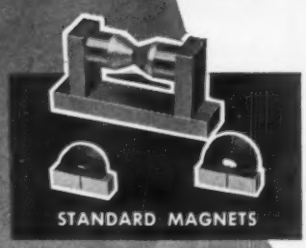

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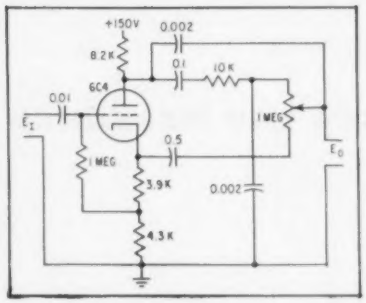

FIG. 4—Use of tube in place of transformer permits phase shifter to handle a wider band of frequencies

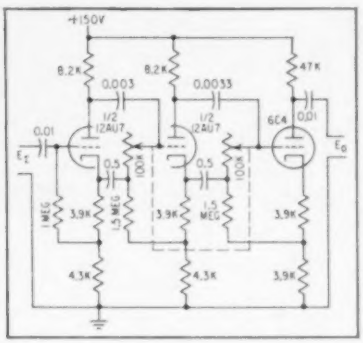

FIG. 5—More than 180 degrees of phase shift and very constant output voltage is provided by two-tube shifter

of the points for E_o does not fall on the circumference of the circle whose center is zero volts, E_o being less in the center of the phase range. A slightly more constant output voltage may be achieved by the circuits shown in Fig. 3.

The transformer may be eliminated by using the circuit shown in Fig. 4, which covers a wider frequency band if suitable values are used. Wide-band operation is achieved because transformer resonance effects are not present at higher frequencies. At lower frequencies the low inductive reactance of a transformer primary does not shunt input voltage source and cause loss of signal or high current flow resulting in core saturation. The values given are approximately correct for 500 to 2,000 cps.

If more than 180-degree range is desired together with very constant output voltage, the circuit of Fig. 5 is recommended. In this circuit, two phase-shifting circuits similar to that in Fig. 1A are cascaded.

Test results at 1,000 cps gave a phase range of 255 degrees and an output voltage constant within 1.5 percent.

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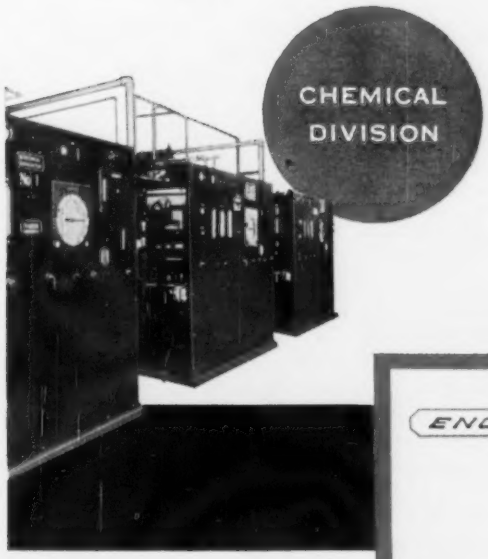

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SINCE TV picture tubes are capable of throwing quite a bit of glass around if they implode, a safety glass must be placed in front of the tube. The price for safety is—a dust gathering surface on the TV tube face and the back of the safety glass; two additional reflecting surfaces to cut down brightness and definition; and very restricted cabinet styling, since the safety glass is mounted in the cabinet.

Direct Connection

A twin panel safety glass which is attached directly to the tube and eliminates these three problems has been developed by Corning Glass Works, Corning, N. Y. It produces a tube that is clean-for-life, since dirt can never reach the picture tube.

The specially curved glass face panel is bonded to the panel skirt of a finished television tube. A transparent liquid with an index of refraction the same as glass, is sealed between both panels. The liquid between panels is non-toxic, non-contaminating and can withstand sudden temperature fluctuations from −40 F to 160 F. It retains its clarity indefinitely. The twin-panel tube will withstand more than 30 G's without failure.

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With the safety glass and television tube sealed into one unit, a dust-proof assembly results, which allows new freedom in the design of smaller more compact sets. In fact the flexibility of cabinet design is probably its most outstanding feature. What the television industry needs most now is a way to sell more sets.

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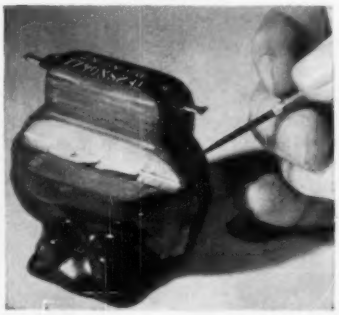

Low viscosity of epoxy encapsulation material gives exceptionally good impregnation of transformer core. Better heat transfer and moisture protection result from the deep impregnation. Thermal shock from −55 to +85 C will not cause encapsulation to crack

thermal shocks from −55 to +85 C without cracking. Thickness of the dip encapsulation is from 1/16 to ¼ inch.

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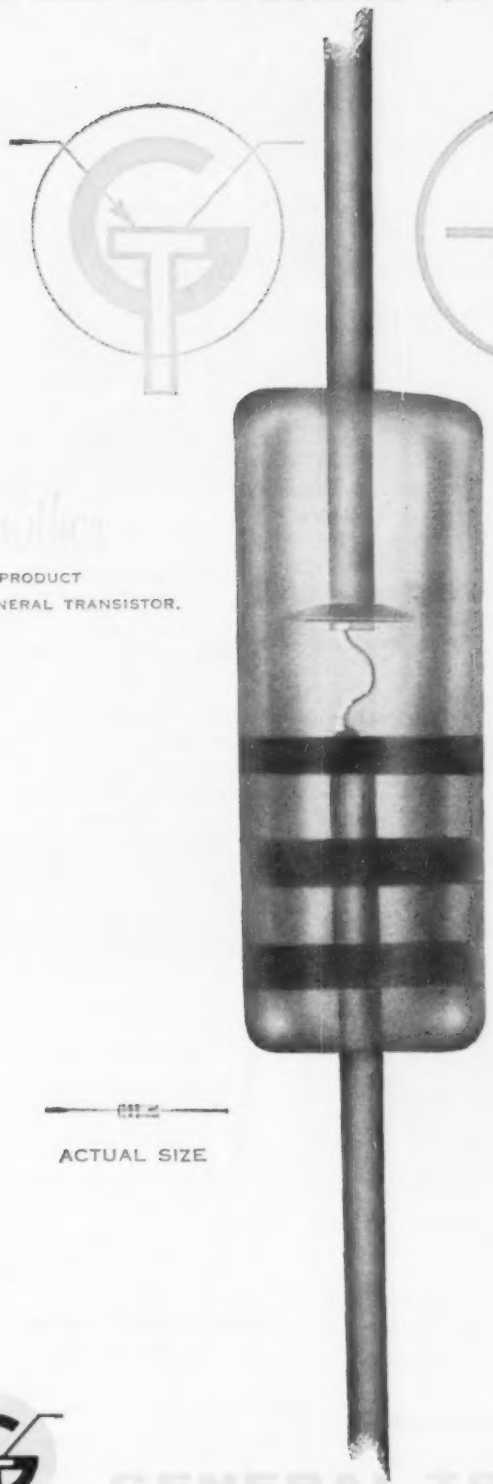

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ELECTRONIC AND AIR DATA SYSTEMS Required are men of project engineering capabilities. Also required are development and design engineers with specialized experience in servo-mechanisms, circuit and analog computer design utilizing vacuum tubes, transistors, and magnetic amplifiers.

SERVO-MECHANISMS AND ELECTRO-MAGNETICS Complete working knowledge of electro-magnetic theory and familiarity with materials and methods employed in the design of magnetic amplifiers is required.

FLIGHT INSTRUMENTS AND TRANSDUCER DEVELOPMENT Requires engineers capable of analyzing performance during preliminary design and able to prepare proposals and reports.

FLIGHT INSTRUMENTS DESIGN Requires engineers skilled with the drafting and design of light mechanisms for production in which low friction, freedom from vibration effects and compensation of thermo expansion are important.

HIGH FREQUENCY MOTORS, GENERATORS, CONTROLS Requires electrical design engineers with BSEE or equivalent interested in high frequency motors, generators and associated controls.

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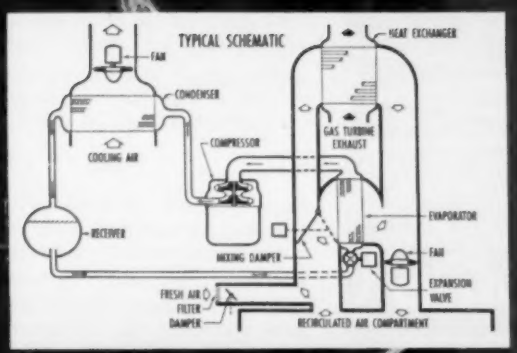
CIRCLE 81 READERS SERVICE CARD

LIGHTWEIGHT
air conditioning for missile support systems



The mobility problem in cooling electronic equipment in vans and for missile pre-launching has been answered by new AiResearch Freon air conditioning units. *One-fourth the weight and one-third the size* of conventional equipment, these lightweight, air-transportable units utilize highly efficient AiResearch Freon components (see diagram) originally developed for commercial aircraft applications.

Heat source for the circuit can be either electrical, or exhaust gas from an AiResearch gas turbine. When the gas turbine assembly includes an alternator, it supplies *400 cycle power to run both the refrigeration unit and all electronic gear in the van.*

Easily operated manually or automatically, this compact air conditioning unit provides from 5 to 12 tons cooling capacity and up to 85,000 BTU's per hour heating capacity. It operates on 400 cycles, 208 volts. The unit shown stands 54" high, 52" wide and 27" deep, with a charged weight of only 452 lbs.! Your inquiries are invited.

SPECIFICATIONS

Performance Data:

Typical operation—cooling

Refrigerant	Freon 12
Evaporator tonnage	7.5
Ambient temperature	100F
Condenser air flow	5000 cfm
Condensing temperature	131F
Evaporator air flow	1230 cfm
External distribution ducting pressure drop	2 in H_2O
Evaporating temperature	48F
Electrical power	26KVA

ENGINEERING REPRESENTATIVES: AIRSUPPLY AND AERO ENGINEERING, OFFICES IN MAJOR CITIES

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AiResearch Manufacturing Divisions

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Specifically for instruments and test consoles which must operate on 50-60 cps in the lab and on aircraft 400 cps power supply. Continuous operation over a frequency range from 45-600 cps without the use of switching components or duplicate power connectors. Long operational life. Meets both military and federal specifications.

Model	Type	Series	Capacitor MFD Rated 220 vac	CFM 60 cps/400 cps		Total Net Pounds	Approximate Dimensions
DF	KRS-301	433A	0.25	28	41	1.1	3"x3"x3"
DFE	KRS-401	434A	0.5	82	102	1.7	4"x4"x3½"
DFE	KRS-4501	435A	1.0	115	160	2.7	4½"x4½"x5"
DRPP	KRS-1504	433A	0.25	9	14	1.2	3"x3"x3½"
DR	KRS-202	434A	0.5	20	25	1.7	4"x3½"x4"
DR	KRS-2501	435A	1.0	33	40	3.0	5"x4½"x5"

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esting he can carefully prepare any questions he would like to ask during the Question and Answer period.

Making Notes

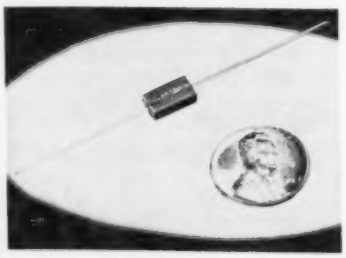
When a person reads the text of a talk he makes use of one sense—sight. When he hears a talk delivered, many additional factors can influence his understanding of the paper. Inflection in the speaker's voice and his facial expression either add importance to a sentence or take away from its significance. Gestures of the speaker can make seemingly stupid text become very understandable. If the engineer in the audience has a bound copy of all conference papers he can write-in the necessary marginal notes to make the papers meaningful to him. After the conference, the book becomes a personal and worthwhile reference.

Ideal

The ideal situation is to have bound proceedings available two weeks before the conference. Attending engineers can then adequately prepare for papers which are particularly interesting to them. It seems almost a natural that conference sessions held under such conditions will be more exciting and interesting.

Copies of the Proceeding of the 1958 Electronic Components Conference can be obtained from the *Engineering Publishers*, GPO Box 1151, N. Y. 1, N. Y.

Smallest Molded Mica Capacitor



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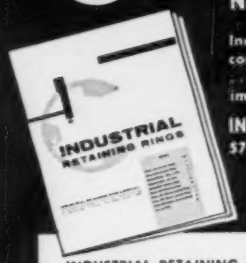

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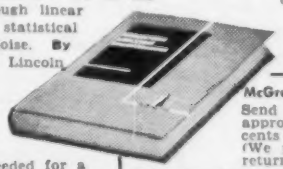
ELECTRON TUBE CIRCUITS

New 2nd Edition Just Published. Discusses and evaluates the fundamental properties of electron tubes and their circuit operations—analyzes tuned and untuned amplifiers—and takes up in detail circuits essential to modern electronic systems such as voltage, video, and power amplifiers; waveform generators; oscillators; modulators, etc. Scores of practical examples show you best applications of theory. **By Samuel Seely,** Case Inst. of Technology. **2nd Ed. 695 pp., 739 illus., $10.50**

BASIC FEEDBACK CONTROL SYSTEM DESIGN

Just Published. Bases the study of feedback control system design on complex frequency plane analysis—the root-locus. A wide range of servo transducers and components are covered. Recent advances covered include a section of gyroscopes and force-balance transducers, inertial navigation; analysis of nonlinear systems such as the describing function technique and phase plane analysis. Frequency methods, such as Nyquist and Bode, are included. **By C. C. Savant,** U. of Southern Cal. **418 pp., illus., $9.50**



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Remember that "dry" or corroded joints, on the production line, lead to slow-ups, rejects . . . cost you money!

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Pre-wetting, by 5 molten cores of flux, insures instant spreading and gripping, even on difficult metals. Yes—it saves money permits lower tin content alloys than you may be using in other solders!

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Conforms with QQ-S-571b and other Federal specifications

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nearest comparable unit has been produced by the Micmold Electronics Division of General Instrument Corporation. It appears to be a big stride in the search for a way to make high-reliability components smaller—especially in missiles which use from 200 to 30,000 capacitors of various types.

Characteristics

The capacitor weighs one-half gram and is .37 inches long, .19 inches wide and .11 inches thick. Capacitance range is from 5 $\mu\mu$f through 240 $\mu\mu$f with tolerances from ± 2 to ± 20 percent. It is available in C or D characteristics in capacitance ranges below 50 $\mu\mu$f and in C, D or E characteristics in capacitance ranges from 51 $\mu\mu$f through 240 $\mu\mu$f. Working voltage is 300 volts at 85C and 200 volts at 125C. Dielectric strength is 200 percent of rated voltage. The new component, called A "Missil-Mite," is available in production quantities.

Funnel Flange Eyelets for Printed Circuits

MOUNTING EYELETS in printed-circuit board holes with a funnel flange, instead of the rolled head usually used to hold eyelets in place, has two major advantages. It permits faster and easier insertion of a component lead in the eyeleted hole whether done by hand or machine. And it provides a mechanically stronger eyelet since the underside of the funnel flange attracts a generous solder fillet when dip soldered.

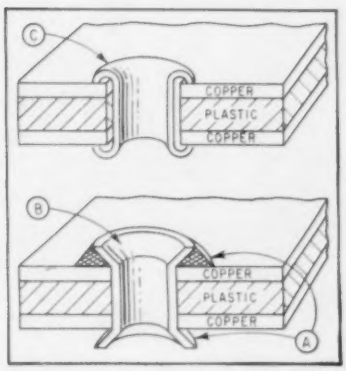
Mounting

Circon Component Corporation, Goleta, Calif. calls their new eyelet a *Funelet*. Because the Funelet is mounted in the printed circuit board by merely spreading one end of the eyelet—instead of the "roll-over, pressdown" operation required with conventional eyelets—rejected assemblies due to imperfect eyelets are practically nil.

Dependability

A quality test of over 300,000 eyelets did not produce any imper-

fect eyelets. The cost savings from jammed equipment, down-time, and damaged work caused by an imperfect eyelet helps offset the slightly higher cost of Funelets.



Funnel Flange eyelet permits easier component lead insertion (B); and solder fillet (A) gives a more reliable structure than rolled-head (C).

Strangely enough even though it was developed as a precision part, Circon claims many of the largest volume users are manufacturers of commercial low cost, competitive printed circuits who willingly pay the added price because of the reliability obtained.

Gold Shot-Burnished

A 24 carat gold, shot-burnished, overlay inside and out is applied with a technique which eliminates "splatter" of plated metal when eyelets are machine set. Gold is first plated to thickness of eighty millionths of an inch. The shot-peining and burnishing process fuses the gold in the surface pore structure of the brass. The resultant surface layer of gold is fifty millionths of an inch thick, highly malleable and will not peel, scale, blister or delaminate when the eyelet is machine mounted.

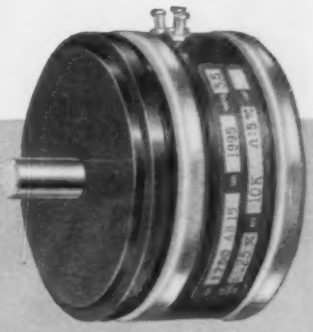
Resistance

Contract resistance of the shot-burnished surface is very low and retains its characteristics in corrosive environments. It is highly solderable even after adverse storage conditions.

Eyelets are available in standard increments of correct size to fit hole diameters varying from $\frac{1}{4}$ in. to $\frac{1}{8}$ in.

A New Complete Line

...COMPETITIVELY PRICED
...ONE OR THOUSANDS
...SINGLE OR GANGED



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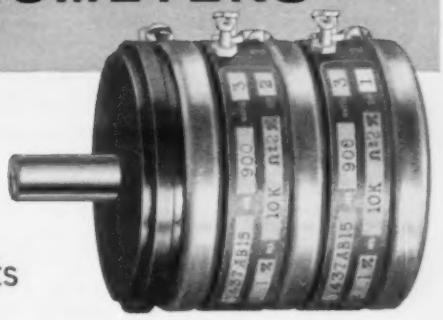

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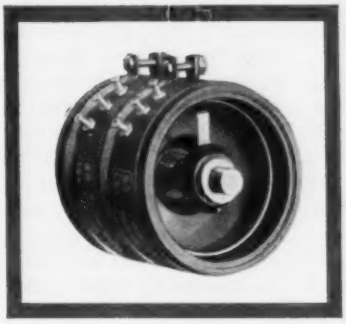

"Giannini Technical Notes" announces various instruments and controls which are available for 24 hour delivery.

ITEM:
Model 1437 (NAS-710, style RRI5)
RESISTANCE: 100 to 160,000 Ω
LINEARITY: 0.5% to 0.1%
RESOLUTION: to 3900 wires

ITEM:
Model 1750 (NAS-710, Style RRI8)
RESISTANCE: 100 to 300,000 Ω
LINEARITY: 0.5 to 0.1%
RESOLUTION: to 5,000 wires

ITEM:
Other Models from $\frac{7}{8}$" to 3" diameter. Ganged units are externally phaseable.

Giannini measures & controls:

ω	β	θ	$\bar{\mu}$	τ	v	φ
δ	Ω	ω	h	P	ΔP	T
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PRECISION INSTRUMENTS AND CONTROLS

Giannini

G. M. GIANNINI & CO., INC., 918 EAST GREEN STREET, PASADENA, CALIF.

Merry-go-round Steps Up Klystron Tube Output

Wheel-like machine simplifies hand sealing operation. Tubes are heated at operator's left and cooled at right. Radioactive brush to clean mica windows is in foreground

Tubes are placed in metal heat concentrators after windows are positioned

ROTARY WINDOW SEALING machines speed kylstron tube output, furnish more positive control over production and require less operator skill. Varian Associates, Palo Alto, Calif., designed and built the machines for $1,100 each.

Merry-go-round takes 16 klystron tubes. At each station, a tube nestles in block of metal which concentrates the heat. Heat is supplied by induction by paired coils of a Lepel heating unit as the tube approaches the operator.

The tube is covered with a small glass bell jar with a hole in its top to allow access by the operator. Nitrogen gas is piped in to provide an atmosphere which will keep the tubes clean and prevent oxidation. Sixteen flow meters in the center of the wheel supply the bell jars.

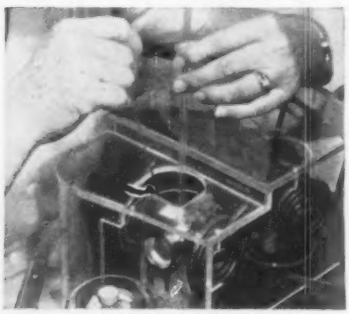
A built-in cooling system directs a blast of cool air on the operator's hands, since she works directly above intense heat.

Mica windows, which cover tube apertures, are cleaned by passing them between radioactive brushes made by Nuclear Products Co., El Monte, Calif. This removes static electricity, freeing lint. The window is placed in the tube's metal flange with tweezers.

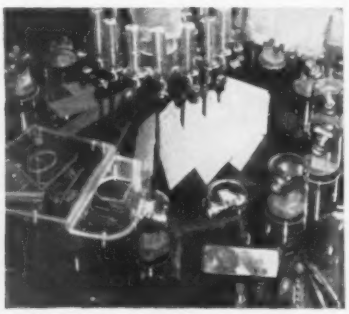
The tube is placed under the bell jar and brought to correct temperature. Special glass is applied around the window seat, which is now hot enough to effect a seal. A weight is placed over the hole in the bell jar to maintain nitrogen pressure while the tube cools.

The wheel is turned to the right and the operations repeated on the next tube, which has been heating. As the sealed tubes make the circuit and cool, they are removed one by one and replaced at a rate of 50 to 60 a day.

The glass used for sealing is made by Corning Glass Co. The flange is Allegheny Ludlum Steel Co. Sealmet, an alloy developed for glass sealing. The two have equal coefficients of expansion.



Glass seal is applied while tube is between heating coils. Tube at right is being brought to sealing temperature



Cards placed between nitrogen flow meters provide permanent production history of each tube

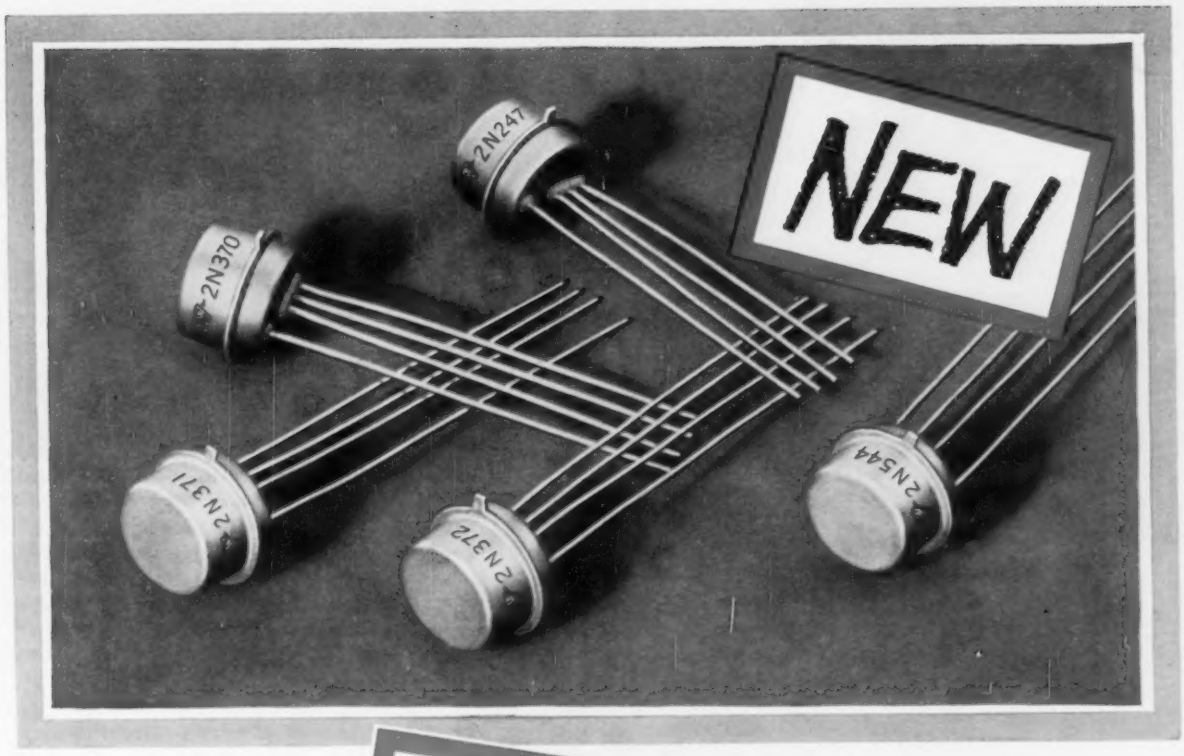
Instruments Boxed On Foam-cushioned Base

FREE FLOATING suspension method of packing is employed by Ampex Corp., Redwood City, Calif., to ship tape recorders. The technique, the firm reports, has reduced customer damage claims to less than ¼ per cent.

Package, made by Crate-Rite Mfg. Co., Oakland, Calif., consists of a fir-plywood floating deck, plywood-covered base framed with lumber, and sides, ends and top of ¼ inch plywood veneer overlaid with paper and glue-laminated to 200-pound corrugated board which forms corners and lap joints.

The base is framed around its perimeter with 2x4's with a 2x2 brace down the center. For forklift handling, 3x4's are spiked to the frame bottom. The 2x4's are covered with ½ inch, 5-ply fir plywood.

The floating platform is made of ⅞ inch plywood for 600-1,000



Sylvania RF-IF Transistors

Five new PNP Drift transistors, types 2N247, 2N370, 2N371, 2N372 and 2N544, for radio frequency amplifier service

Sylvania's new PNP Germanium Drift transistors feature high output resistance for increased gain at 1.5 mc to 20 mc, low feedback capacitance and high alpha cutoff frequency.

Designed for RF-IF circuits, they open the door to more transistorized electronic equipment operating from the broadcast band to the higher frequencies.

The new Sylvania drift transistors incorporate a diffused base on an intrinsic germanium layer for improved control over base thickness, more uniform base region, lower base resistance and reduced collector capacitance. The end result is superior performance at higher frequencies.

The new PNP drift transistors feature Sylvania welded hermetic seal construction for maximum protection in rugged environments. They are encased in a modified JETEC class 30 case with four flexible in-line leads. The additional center lead is connected to the metal case providing a complete unit shield and interlead shield. Coupling to adjacent circuit components is reduced to a minimum.

Call your Sylvania Sales Representative or write direct for information on new Sylvania PNP drift transistors, types 2N247, 2N370, 2N371, 2N372 and 2N544.

ELECTRICAL CHARACTERISTICS (25°C)

	2N247	2N370	2N371	2N372	2N544	Unit
Power Gain, P_E						db
V_{CE}= -8, I_E=1 ma, Freq.=20.0 mc						
Minimum	24	10	12	10	30.5	
Typical	27	—	—	—	—	
Maximum	31.5 (V_{CE}= -9 req.= 1.5 mc)	17	17	17	37.5 (V_{CC}= -9) (Freq.= 1.5 mc) (R_L =750 ohms) (Neutralized)	
Reverse Biased Collector Voltage, V_{CB}						V
V_{EB}= -0.5, I_C=50 ua						
Minimum	-40	-20	-20	-20	-20	
Typical	—	—	—	—	—	
Maximum	—	—	— (I_C =.050 ma)	—	—	
Collector Base Capacitance, Cob						uuf
V_{CB}= -12, I_E =0, Freq. =1.5 mc						
Minimum	—	—	—	—	—	
Typical	1.5	—	—	—	—	
Maximum	2.5 (V_{CB}= -9)	2.5	2.5	2.5	2.5	

SYLVANIA

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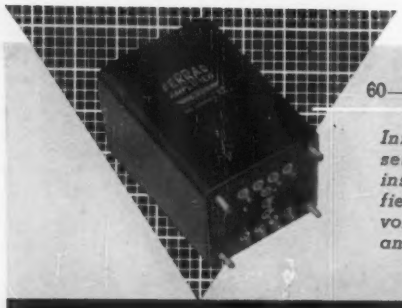


60—CPS MAGNETIC AMPLIFIER

Initial stand-off error (zero offset) of this Ferrac DC-to-DC instrument type magnetic amplifier does not exceed ±120 millivolts with changes in operating and environmental conditions.

Magnetic DC Amplifier Has High Stability and Long Life

For industrial automatic controls and ground military tracking equipment, Ferrac magnetic amplifiers provide exceptional stability. These hermetically sealed units require no bias or compensation; null balance is permanently built in. They operate directly from 115-volt 60-CPS power line. Standard units are available from current production for general purpose, thermocouple amplifier, integrators, and high gain (5 volts out for 100 microamperes in).

CHARACTERISTICS

INPUT: *Two independent control windings for reversible DC.*

OUTPUT: *Unfiltered DC linear over the range ±7.5 volts into 1000-ohm load.*

POWER REQUIREMENT: *Less than 3.5 VA at 115 ±11 RMS volts at 60 ±6 CPS.*

GAIN: *Gains of standard Ferrac amplifiers are expressed as transresistance. To obtain output, multiply input by transresistance.*

Type	Transresistance Control A	Transresistance Control B
M-5284	25 x 10^3	25 x 10^3
M-5267	5 x 10^3	100 x 10^3
M-5268	50 x 10^3	50 x 10^3
M-5285	5 x 10^3	6.4 x 10^3

Actual gains are held within ±0.2 volt of nominal values at 5 volts output and are stable within ±0.5 volt at 5 volts output with changes in ambients.

ENVIRONMENT: *Ferrac amplifiers operate from −55 C to +85 C, withstand 10 G vibrations at 10 to 2000 CPS, and shocks of 30 G for 11 milliseconds along principal axes; they are hermetically sealed.*

DESIGNERS AIRPAX PRODUCTS COMPANY ENGINEERS

Airpax Products Company, Seminole Division, Fort Lauderdale, Florida

Floating base goes on foam blocks. Bolts in base are capped with springs

pounds units, appropriate thicknesses for other weights and crate sizes. The box used for most shipments is 90x40x36 inches and is shipped horizontal. It may contain several units of smaller size.

In packing, the instrument is first covered with a ¼ inch padding and a 4-mil polyethylene bag left unsealed to prevent interior condensation.

The platform is secured to the base with 8 steel coil springs bolted through base and platform. The springs, to absorb shock, are wrapped to protect the cabinet finish. Separating the base from the floating deck are 2 inch pads of polyurethane foam held in place by the springs and distributed according to the weight of the shipment.

A pad is laid over the deck and the instrument is laid on this and strapped with 3 steel bands placed

Padded and bagged recorder is strapped to padded base. Springs have been padded also

Sides and top of box are taped and stapled in place

over double wrappings. The veneer sides and ends are stapled in place. End and side joints are taped and the top is stapled. Battens of 1x4 inch lumber brace the tops.

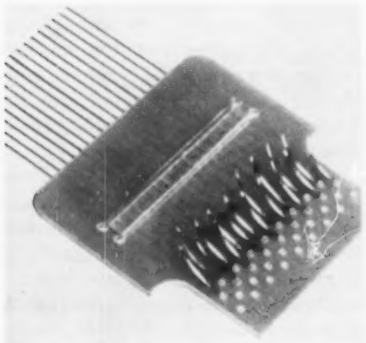
Advantages over previous packaging methods are reported as reductions in cost, packaging time and shipping weight, a clean surface for printing identification or advertising and standardization of package size.

Plates Connect Ribbon Cable to Terminals

PREPUNCHED supporting plates suitable for connecting ribbon cables to printed circuit boards or mating female terminals are employed in a connector family made by Elco Corp., Philadelphia, Pa.

Ribbon cables with conductors embedded in plastic or with conductors printed on one or both sides of plastic are joined by similar methods. Any spacing or pattern can be handled.

First step with the embedded conductor type of cable is to remove the insulation from ½ inch at the



Bare conductors fed through holes of contact plate

G-V thermal time delay relays... protect cathodes in RCA's TV microwave relay system

When the industry required a portable microwave repeater station that behaved like a permanently installed, unattended unit, RCA developed its Television Microwave Relay Station, Type TVM-1A. In it, to protect the unit's cathodes, RCA design engineers rely on G-V thermal time delay relays to delay the application of plate voltage.

In both industrial and military equipment, G-V thermal relays are providing long, dependable, proven service in time delay applications, voltage and current sensing functions and circuit protection.

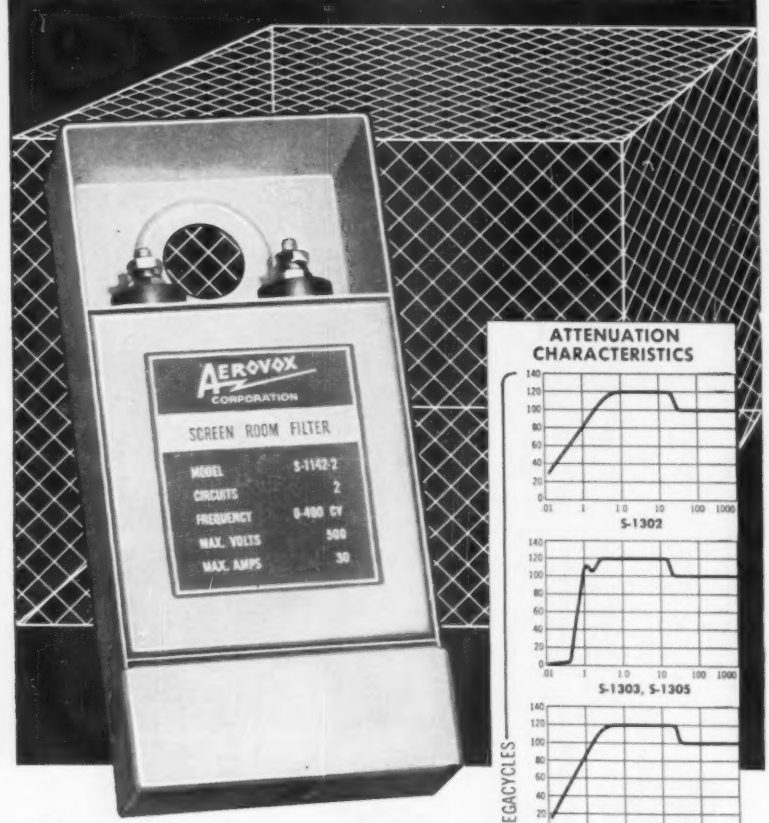
Write for extensive application data and catalog material.

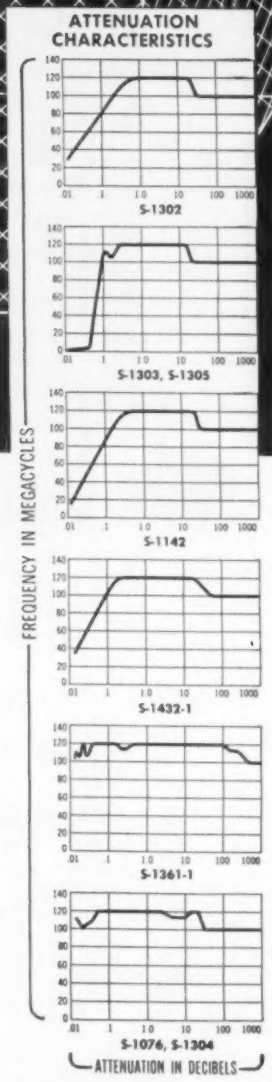
G-V CONTROLS INC.

24 Hollywood Plaza, East Orange, New Jersey

G-V

AEROVOX-ACME SCREEN ROOM FILTERS





Choose from a wide range of attenuation patterns from 14kc to 10,000 mc.

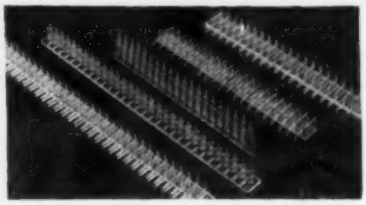
Aerovox offers a complete selection of high attenuation screen room filters in single, double and triple section units to comply with the rigid specifications of advanced type screen room designs. Each filter is hermetically sealed and terminals at both ends are shielded. Easy mounting arrangements plus high attenuation performance assures you of the finest equipment specifically designed for screen room use.

Write for technical details to . . .

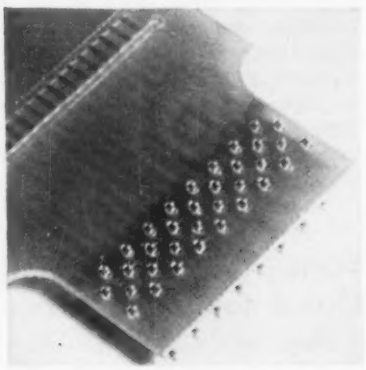
AEROVOX CORPORATION

NEW BEDFORD • MASSACHUSETTS

end of the cable. Bared conductors are placed on top of a prepunched supporting plate to line up with contact leg holes in the plate. Loose ends of the conductors are pushed through the contact leg holes.



Contacts on plastic strips fit into holes in plate



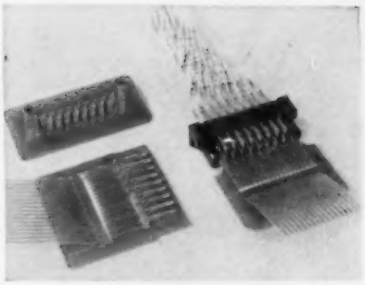
After contacts are staked and excess conductor cut off, plate is ready for solder

The required number of lower tier contacts, supplied on plastic strips, are inserted through the corresponding holes of the supporting plate and staked to the board. A pad presses the cable against the supporting plate, fastening the cable to the board. The contact leg presses against the bare conductor at the hole of the supporting plate, bonding contact and cable conductor.

After removal of the plastic strip, the upper tier contacts are inserted and staked. Excess conductor material is cut off and the supporting plate is dip-soldered on the staked side.

The supporting plate has two slots through which the free end of the cable is fed. This secures it to the plate, preventing strain at connector joints.

Cables with printed conductors already have bare conductors at the points of connection with holes, corresponding to the contact leg



Other side of support plates, with taper tab and stand-off contacts

location. The cable is placed on top of the supporting plate so that the conductors line up with corresponding contact leg holes in the supporting plate. Contacts on plastic strips are inserted and staked as described previously.

In both, the staking creates a pressure connection between contact tail and conductor. Soldering gives a second independent connection, thus increasing the reliability of the joint.

Peephole Packing Case

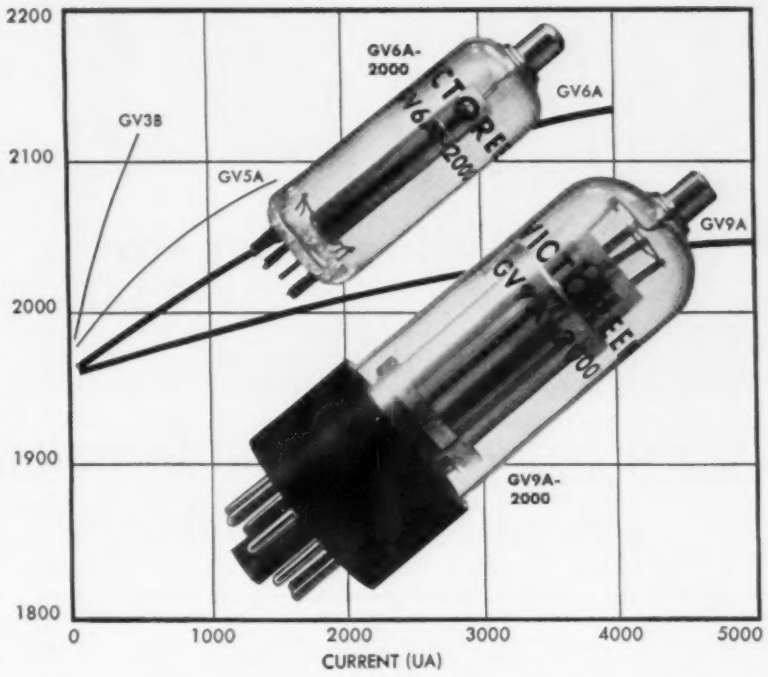
CORRUGATED cardboard cartons used to ship portable television receivers made by Admiral Corp., Chicago, Ill., contain three knife cut sections. Two viewing slots 5 by 7 inches provide access to the picture controls and power cord. Another, 4 by 1½ inches, exposes a portion of the picture tube. A dealer can check out the packed receiver by merely pressing in the knife-cut sections, eliminating the necessity for opening and resealing the carton. A heavier than normal corrugated material is used to increase the strength of the carton for warehousing and shipping.

Acid Sharpens Files

WORN hand files and similar tools may be sharpened in an electrolytic sulphuric acid bath. Files are placed as anodes in a 56 percent solution of acid in a lead-lined tank. Cathodes are stainless steel. As a current of 100 amperes at 8 to 10 volts dc passes through the bath, the teeth of the files are eaten away so that a new cutting edge is formed on each tooth.

NOW... *from Victoreen*

CORONA TYPE HIGH VOLTAGE REGULATORS WITH CURRENT CAPABILITIES AND SLOPES NEVER BEFORE OBTAINABLE



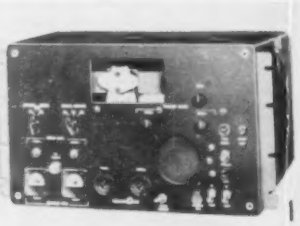
- Maximum currents to 4 ma
- Peak currents to 9 ma
- Regulation to 1.5%/ma
- Voltages from 400 to 3000
- 9 pin and octal base tubes
- In use by the military

Make Victoreen your headquarters for high voltage regulation. Send for Form 2022A and Form 2023A describing the GV6A and GV9A line of corona type voltage regulators.

The Victoreen Instrument Company
Components Division
5806 Hough Avenue • Cleveland 3, Ohio

New Tape Equipment Arrives

1. OLYMPIC RADIO & TELEVISION CO.
   Recorder-Reproducer
2. PRESTO RECORDING CORP.
   Professional Tape Recorder
3. TELECTRO INDUSTRIES CORP.
   Tape Transport
4. POTTER INSTRUMENT CO., INC.
   Random Access Memory
5. LIBRASCOPE, INC.
   Tape Demagnetizer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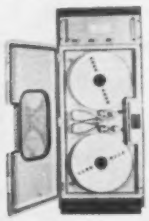
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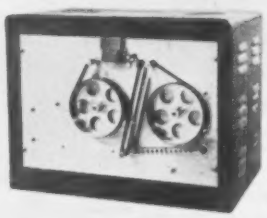
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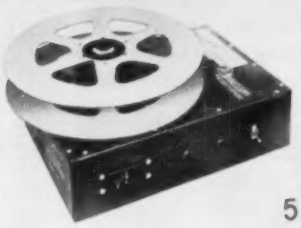

5

Industry, Military Benefit

Both entertainment and data recording keep interest in magnetic tape and associated electronic and mechanical equipment high. Industrial and military applications are constantly increasing.

Olympic Radio & Television Co., 34-01 38th Ave., L. I. C., N. Y., (300), announces model RX-118 magnetic tape recorder-reproducer. It is adaptable for use in airport tower work, Naval sonar recording, FCC broadcast monitoring and other applications. It records one or two separate audio channels simultaneously on one reel of tape for 24 hours without reloading.

Now available from **Presto Recording Corp.**, P. O. Box 500, Paramus, N. J., (301), is the 800 series of professional tape recorders designed for radio stations and industrial users. They feature three motors, a 10½ reel capacity and solenoid-actuated brakes, whose new design eliminates frequent readjustment.

Telectro Industries Corp., 35-16 37th St., L. I. C., N. Y., (302), has developed the TA-1085, a 14-channel magnetic tape transport that drives the tape with extremely low flutter. Modes of operation—"record," "playback," "fast forward," "stop" and "fast rewind"—may be remotely controlled.

Model 3270 miniature random access memory is offered by **Potter Instrument Co., Inc.**, Sunnyside Blvd., Plainview, L. I., N. Y., (303). It consists of a tape transport mechanism with transistorized drive and programming circuitry. Each of the two reels on the transport contains approximately 35 ft of one-in. tape.

Librascope, Inc., 40 E. Verdugo Ave., Burbank, Calif., (304), has in production a large type tape demagnetizer for broadcasting and data tapes. Reels up to 10½ in. in diameter for tape widths up to 2 in. can be handled. Rapid degaussing is accomplished through the automatic turntable which eliminates the hand rotation method.

For more information use READER SERVICE Card

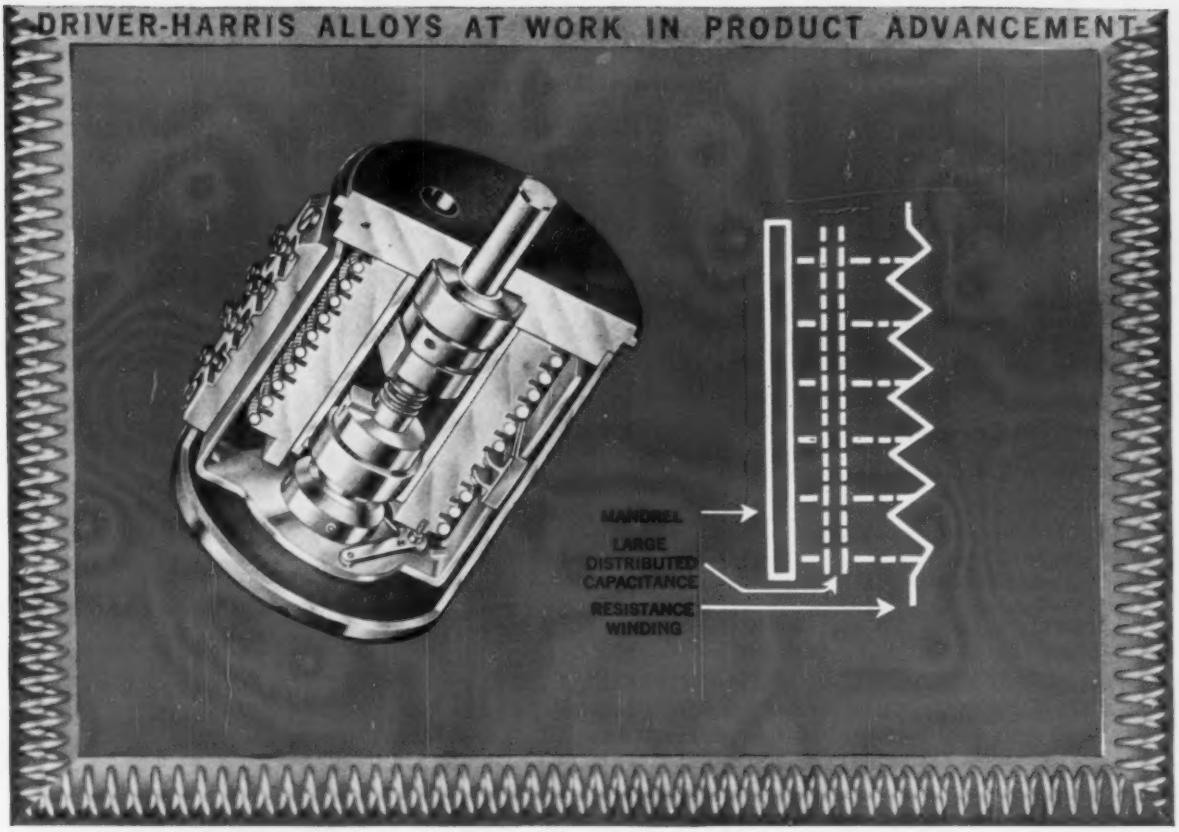
Electrostatic Source for lab experiments

Forest Products, Inc., 131 Portland St., Cambridge, Mass. A new electrostatic generator, designed for laboratory experiments requiring a continuous source of static electricity, stands 17½ in. high and creates a usable charge of 150,000 v at 5 μa.

Similar in design and operation to the multi-million volt electrostatic generators used for atomic research, the new generator is of a size that makes it ideal for industrial laboratories and other similar uses. **Circle 305 on Reader Service Card.**

(Continued on page 118)

DRIVER-HARRIS ALLOYS AT WORK IN PRODUCT ADVANCEMENT



Phase Shift Compensation Eliminated In New HELIPOT® Precision Potentiometers

SPECIAL D-H ALLOYS MAKE AIR-CORE WINDINGS PRACTICAL!

Helipot's purpose in designing its new, air-core wound series 7700 Potentiometers was to make possible operation at higher frequencies with 0° phase shift—thereby eliminating compensation circuitry.

In nearly all multi-turn potentiometers, resistance wire is wound on an insulated copper-wire mandrel. This type of mandrel is used because it has uniform diameter, good heat conductivity and high thermal capacity. However, a disadvantage of such construction is the relatively large distributed capacitance between the resistance winding and the mandrel. When such a potentiometer is used as an AC voltage divider, the output generally differs in phase and magnitude from the desired output. This interferes with the effective use of high accuracy potentiometers unless compensation is applied somewhere in the circuit.

Helipot engineers desired to eliminate these problems by eliminating the copper-wire mandrel. But the elimination of the mandrel also eliminated the support for the winding. Needed, therefore, was a type of wire that would make a self-supporting air-core winding.

At Helipot's request, Driver-Harris went to work with these specifications: The wire must be of dependable uniform hardness so that in stretching it, equal spacing between turns is obtained, free of creep. This is essential to linearity. The wire also must be of unvarying diameter for uniform resistance. And its surface must be extremely clean—free of oxide coating to minimize contact "noise".

Driver-Harris produced the wire—a special hard-drawn form of Karma* and Nichrome* V. And Helipot produced its new 10-turn series 7700 potentiometers in a resistance range from 200 to 5000 ohms. With this radically new air-core winding, linearity approaches the resolution of the unit without resort to padding or shunting. And phase shift in AC circuitry is reduced to less than 0.1°.

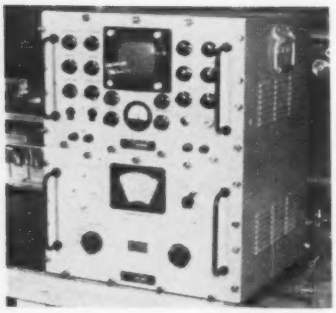
Since 1899, Driver-Harris has produced 132 special-purpose alloys in just this fashion—in answer to a particular problem and extraordinary specifications. If your own engineering and product development plans currently hinge upon a special alloy—why not bring your problem to Driver-Harris. Your inquiry is invited.

*T.M. REG. U.S. PAT. OFF.

Driver-Harris* Company

HARRISON, NEW JERSEY • BRANCHES: Chicago, Detroit, Cleveland, Louisville
Distributor: ANGUS-CAMPBELL, INC., Los Angeles, San Francisco • In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario

MAKERS OF THE MOST COMPLETE LINE OF ALLOYS FOR THE ELECTRICAL, ELECTRONIC, AND HEAT-TREATING INDUSTRIES



Spectrum Analyzer precision unit

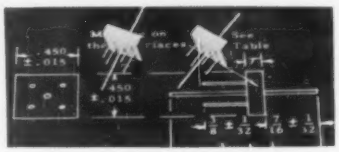
LAVOIE LABORATORIES, INC., Matawan-Freehold Road, Morganville, N.J., offers a no-klystron spectrum analyzer of laboratory precision, with rock-stable oscillators permitting observation of signals with minor instability characteristics.

A simplified band-switch arrangement permits coverage of 10 mc to 21,000 mc range in seconds, and a single head construction precludes misplacing expensive tuning units. Triple shielding allows operation in fields exceeding 4 megawatts without spurious responses.

The spectrum analyzer has a shock performance of 37 g 10 millisec duration in transit case, vibration of 10-55 cps, 10 g, and meets all environmental specifications. **Circle 306 on Reader Service Card.**

Coaxial Capacitor meets MIL-C-10950B

VITRAMON, INC., Box 544, Bridgeport 1, Conn., offers coax capacitors made by its process of combining porcelain dielectrics and fine silver electrodes in a monolithic block. A terminal at the center of



the square capacitor permits currents to flow radially through the electrodes and dielectrics to the four terminals at the periphery of the part. The geometry results in cancellation of magnetic fields of these radial currents and low effective inductance of the capacitor. Rugged design can take vibration up to 2,000 cps with 20 g of acceleration applied. **Circle 307 on Reader Service Card.**

Pulsed Oscillator high power unit

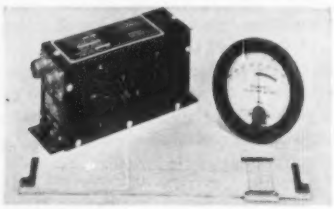
ARENBERG ULTRASONIC LABORATORY, INC., 94 Green St., Jamaica Plain 30, Mass. Model PG-650 oscillator is a variable frequency pulse modulated r-f source for applications requiring high power output as well as extreme stability. Its principal use has been in measuring the various parameters of ultrasonic delay lines whose high initial insertion loss as well as operation at low impedance levels have presented many difficulties in the past.

The r-f output may be displayed directly on the plates of a cro, and the output of a delay line (60 db into 50 ohms) can also be shown at r-f using only the vertical amplifier of the cro and no other. **Circle 308 on Reader Service Card.**

Adjustment Pot is humidity proof

BOURNS LABORATORIES, INC., Riverside, Calif., announces a new leadscrew-actuated adjustment potentiometer which is sealed against humidity and capable of 135 C

operation. Model 236 Trimpot meets military humidity specs. It has a 0.8 w power dissipation, and employs a new element termination termed Silverweld, and ceramic card, providing maximum stability and reliability. **Circle 309 on Reader Service Card.**



Frequency Meter precision device

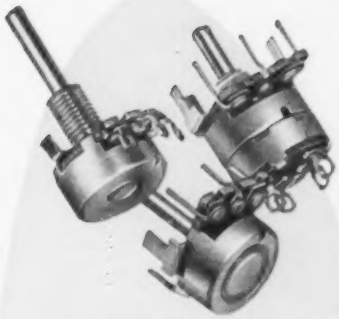
VARO MFG. CO., INC., 2201 Walnut St., Garland, Texas. Model 6506 is designed to fill the need for a precision frequency measuring device for missile and aircraft 400 cps power sources. The transistorized meter provides 0.05 percent accuracy at 400 cps by calibration of the discriminator with an internal tuning fork. Accuracy of 0.1 percent is achieved at full scale, 397 to 403 cps. **Circle 310 on Reader Service Card.**

Tiny Resistor has wide range

ELECTRA MFG. CO., 4051 Broadway, Kansas City, Mo., has avail-

able a new ⅛ w deposited carbon resistor with standard coating (DCX ⅛) that has a resistance range of 25 ohms to 1 meg.

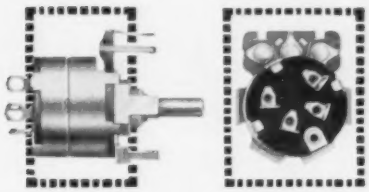
This precision subminiature re-



WHEN IT COMES TO MINIATURE CONTROLS...

CHECK THE OVERALL SIZE...

including switch, if needed. For practical space-saving ability, Stackpole miniature "F" Controls lead the way — only 0.637" in diameter behind the panel for the entire length of *both* control and switch.



Photos show side and rear views of a Stackpole F Control with 2-pole switch. Dotted lines indicate behind-panel space occupied by a conventional "miniature" control.

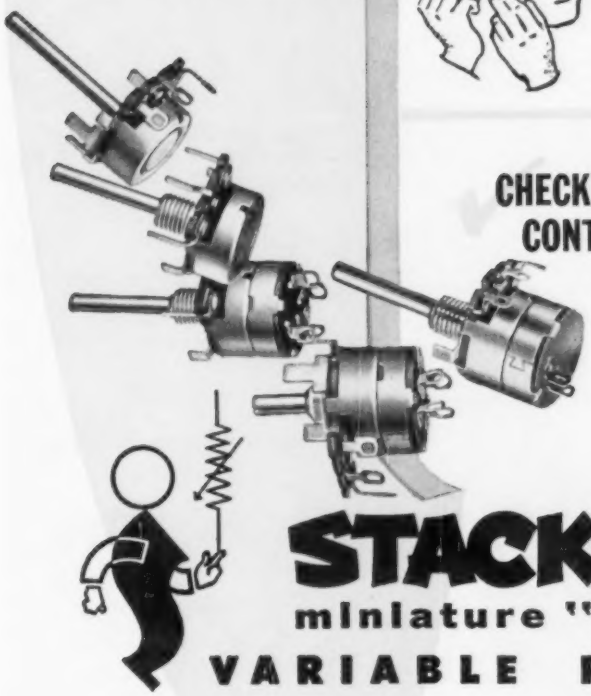
Notice how Stackpole's small switch size perfectly complements the miniature control . . . saves precious chassis space where it's needed the most.

FEEL and HEAR THE SWITCH ACTION...

for the tease-proof, positive "feel" and audible "click" only a true snap-action switch provides. "B"–Series switches used on "F" Controls have the same time-proven mechanism as larger Stackpole control switches. They're U.L. Inspected for 1 amp. @ 125v ac-dc; 4 amps @ 25v dc.

CHECK THE COMPLETENESS OF BOTH CONTROL and SWITCH LINES

Printed wiring, wire-wrap, or standard lug terminals as well as fold-tab or threaded bushing mountings are available on all Stackpole miniature "F" controls. *Both* SPST and DPST switches can be supplied.



STACKPOLE

miniature "F"-series VARIABLE RESISTORS

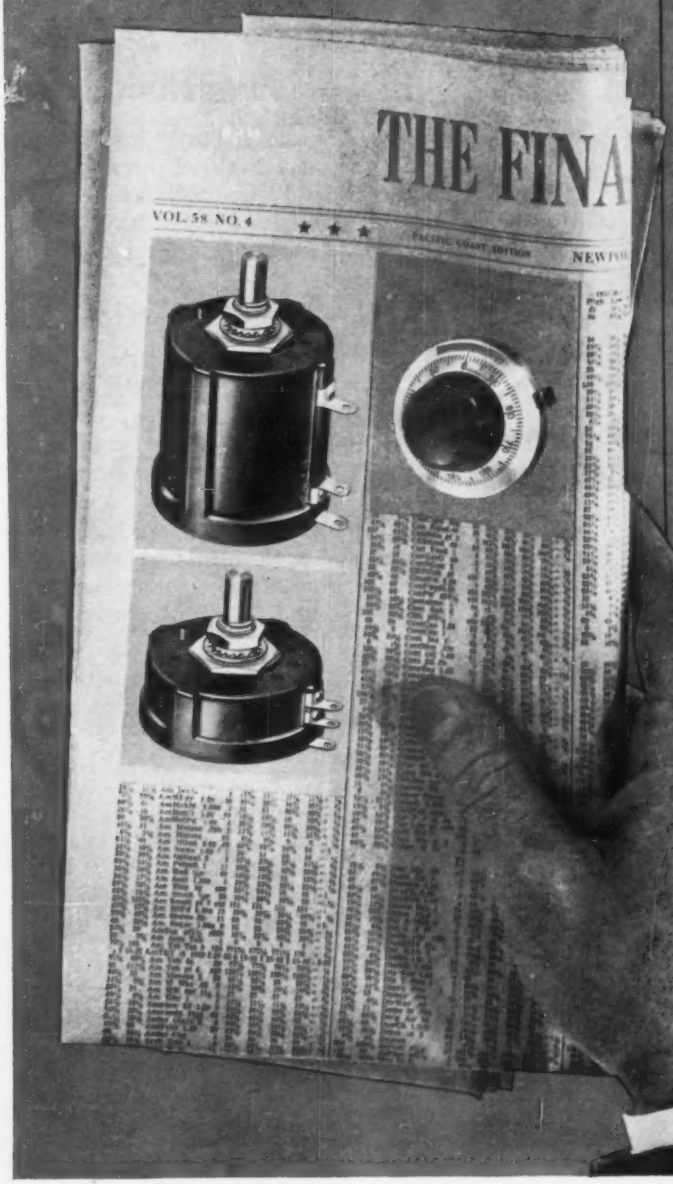
Electronic Components Division

STACKPOLE CARBON COMPANY, *St. Marys, Pa.*

In Canada: Canadian Stackpole Ltd., 550 Evans Ave., Etobicoke, Toronto 14, Ont.

FIXED & VARIABLE COMPOSITION RESISTORS • SLIDE & SNAP SWITCHES • IRON CORES • CERAMIC MAGNETS
FIXED COMPOSITION CAPACITORS • CERAMAG® FERROMAGNETIC CORES
HUNDREDS OF CARBON, GRAPHITE, AND METAL POWDER PRODUCTS.

THIS STOCK PAYS DIVIDENDS



Helipot declares a 3-in-1 potentiometer dividend for you:

Quality . . . . . blue chip!
Price . . . . . best buys!
Delivery . . . . . same day!

Every Helipot representative carries these market-leaders on his shelf for over-the-counter sales:

Series A . . . 10 turns. 1-13/16" diameter. Total resistance: 15 standard values from 25 to 300,000 ohms. Linearity ±0.5% or ±0.1%.

Series C . . . 3 turns. 1-13/16" diameter. Total resistance: 10 standard values from 10 to 50,000 ohms. Linearity ±0.5%.

Series RB Duodial® turns-counting dials . . . accuracy 0.01 turn. A perfect match for Series A potentiometers.

Most reps also stock Series AJ, 10-turn, 7/8" diameter miniatures . . . HELIPOT® single-turns . . . Duodial series 900, R and SR.

All can provide modified HELIPOT precision potentiometers in 10 days or less, at no extra cost!

As you can see, your Helipot representative is a man to see . . . you'll find him listed in the adjoining column.

Beckman® / Helipot

Helipot Corporation
Newport Beach, California
a division of
Beckman Instruments, Inc.
Engineering representatives in 27 cities

Your Helipot Rep is the Man to See

For same-day delivery of stock models...for modified pots in 10 days or less at no extra cost...for any potentiometer requirement... get in touch with

Angus-Sloane Associates
13 East Main St., Moorestown, N. J.
BElmont 5-1900
Teletype MOORESTOWN NJ 1050

Bivins & Caldwell, Inc.
1923 No. Main St., High Point, N. C.
HIgh Point 2-6873
Teletype HIGH POINT NC 454
3133 Maple Dr., N.E., Atlanta 5, Ga.
CEdar 3-7522, Teletype AT 987

Elitron Engineering Sales Co.
246 Walnut Street
Newtonville 60, Mass.
DEcatur 2-6975
Teletype NEWTON MASS 211
2345 Whitney Ave., Hamden, Conn.
ATwater 8-9276

Harris-Hanson Company
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St. Louis 17, Missouri
MIssion 7-4350, Teletype WEB 237
7916 Paseo Avenue
Kansas City 30, Mo.
HIland 4-9494, Teletype KC 448

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Fort Myers, Fla., WYandott 5-2151
Teletype FT MYERS FLA 458
P. O. Box 2492, Gainesville, Fla.
FRanklin 2-8028

Roy J. Magnuson
3347 West Irving Park Road
Chicago 18, Illinois
KEystone 9-7555, Teletype CG 913
1359 West Maynard Drive
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Redwood City, Calif.
EMerson 6-8214
3915 East Broadway, Tucson, Ariz.
EAst 7-1501
3525 Fifth Ave., San Diego, Calif.
CYpress 8-8234, 8-8235

Norvell Associates
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LAkeside 6-7861, Teletype DL 1082

E. A. Ossmann Corp.
830 Linden Ave., Rochester 10, N. Y.
LUdlow 6-4940, Teletype RO 189
1204 South Ave., Syracuse 7, N. Y.
GRanite 6-7073
147 Front Street, Vestal, N. Y.
ENdicott 5-0296

Sheridan Associates
Roselawn Center Bldg.
Cincinnati 37, Ohio, MElrose 1-2460
5348 Pearl Rd., Cleveland 29, Ohio
TUxedo 4-8060

S. Sterling Company
15310 West McNichols Road
Detroit 35, Mich., BRoadway 3-2900

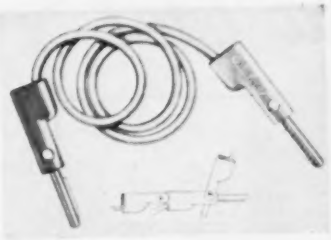
Samuel N. Stroum Co.
1612 Broadway, Seattle 22, Wash.
EAst 3-6117, Teletype SE 403

B. B. Taylor
2270 Grand Ave., Baldwin, N. Y.
BAldwin 3-8000
Teletype FREEPORT 1676

Allen I. Williams Company
126 West 12th Ave., Denver 4, Colo.
MAin 3-0343, Teletype DN 134-x

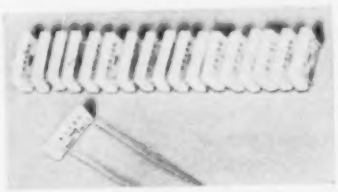
Canada: R-O-R Associates, Ltd.
1470 Don Mills Road
Don Mills, Ontario, Canada
Toronto HIckory 4-4429
6201 Cote St. Luc Road
Montreal, Quebec, DExter 0845

sistor has a diameter of only $\frac{3}{32}$ in., a length of only $\frac{3}{16}$ in. The resistor is made to meet or exceed MIL-R-10509B. **Circle 311 on Reader Service Card.**



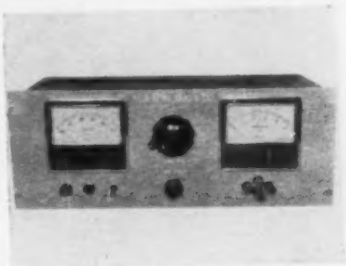
Connecting Lead
spring action tip

ASSOCIATED ENGINEERING CORP., 65 Kent St., Brookline 46, Mass., has announced the new bi-axial Addaplug connecting lead for general purpose hookup and interconnection of equipment, instrumentation work, breadboards, servo set-ups and the like. Addaplug reduces equipment setup time and insures safe, positive connections. Exclusive spring action tip is self-wiping and always insures a good connection, with uniform, low contact resistance (less than 0.001 ohm). Addaplug will withstand a tensile force of at least 20 lb and will resist failure due to flexing at junction of plug and wire. **Circle 312 on Reader Service Card.**



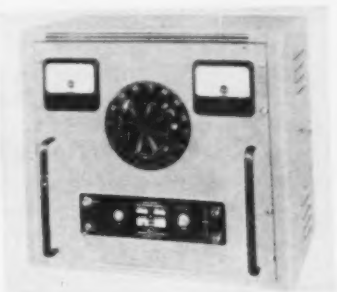
Tiny Capacitors
radial series

VITRAMON, INC., Box 544, Bridgeport 1, Conn. Radial series capacitors illustrated offer a 300 v rating up to 100 $\mu\mu$f. They feature thin design—$\frac{3}{64}$ in. to $\frac{3}{32}$ in.—and can be mounted axially, radially, or on edge. Due to the company's manufacturing process no case or hermetic seal is needed. They feature complete humidity immunity, Q in excess of 2,500, dissipation factor less than 0.0003, insulation resistance greater than 50,000 ohm farads, capacitance drift less than 0.05 percent. **Circle 313 on Reader Service Card.**



D-C Power Supply
all-transistorized

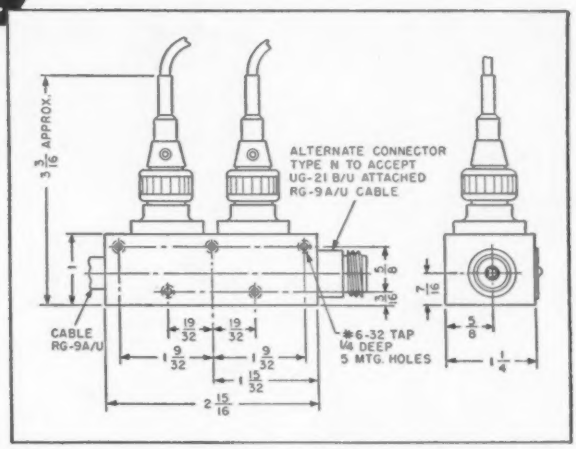
SILA-KON ENGINEERING CO., P.O. Box 282, El Monte, Calif. Powered from 115 v a-c, the model 550 variable d-c power supply utilizes transistor circuitry throughout to achieve a high degree of regulation. It incorporates overload protection that can be pre-set with a calibrated panel control for protection of the load. Another feature provides for remote sensing of the voltage at the load. **Circle 314 on Reader Service Card.**



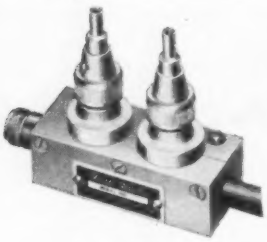
D-C Power Supply
medium voltage

OPAD ELECTRIC CO., 69 Murray St., New York 7, N. Y. Model RS40B is a medium voltage germanium rectifier power supply. It has a continuously adjustable output of from 0 to 110 v d-c with a maximum load current rating of 20 amperes. Ripple does not ex-

No Transmitter should be without one!



OUTLINE DRAWING MODEL 575N DOUBLE COUPLER



WHEN YOU BUILD MicroMatch Directional Couplers into your transmitters, you add an invaluable feature at extremely low cost — positive confirmation of transmitter performance. Your customers stay sold by the coupler's continuous RF Power indication. Its VSWR monitor, in addition, stands watch over your customer's transmission line and antenna.

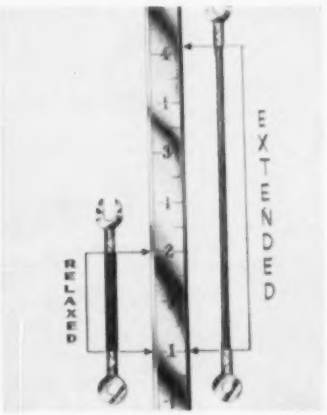
Now incorporated in most modern Government and commercial transmitters, MicroMatch Directional Couplers produce an output essentially independent of frequency. Units are available for use within the range of 20 to 4000 megacycles. Couplers are adjusted to produce full scale meter deflection at power levels of 1.2 watts to 120 KW. Accuracy of power measurements is plus or minus 5% of full scale.

For complete details on the MicroMatch line of monitoring equipment, write for our 68-page catalog.

WHEN MICROMATCH IS BUILT IN- YOU KNOW WHAT'S GOING OUT

M.C. JONES ELECTRONICS CO., Inc.
BRISTOL, CONNECTICUT

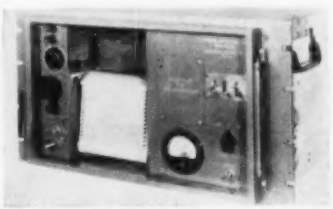
ceed 1 percent of the average d-c output throughout the range of the equipment. Regulation is 5-6 percent from 1/10 load to full load at 110 v output. **Circle 315 on Reader Service Card.**



Stretch Cables 2-ampere capacity

STRETCH WIRE CORP., P.O. Box 893, New Rochelle, N. Y. Illustrated is a single conductor of 2 ampere capacity with a resistance of 0.18 ohm in a relaxed and extended state. It has a stretch factor of 200 percent, and stretches and retracts easily.

Cables can be constructed with controlled extension factors in the required number of conductors and built to meet the current capacity of the required cords. Terminations are in spade, clip, probe or round. Jackets are of nylon, rubber or neoprene. **Circle 316 on Reader Service Card.**

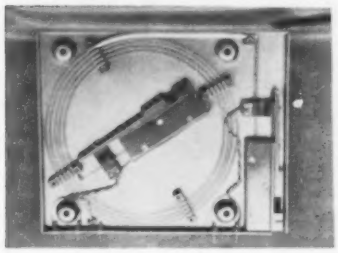


Level Recorder for rugged conditions

SOUND APPARATUS CO., Stirling, N. J. The marine level recorder, model SL-4M, has been specially designed for operation in humid

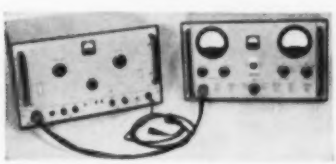
and rugged conditions which often exist in tropical climates, or aboard ships or in the field. It is a compact, rack-mounted recorder (4 in. recording width) for frequency response, sound, noise, and vibration measurements.

The unit features complete moisture-proof, anodyzed metal enclosure; Plexiglass hinged door on front panel, protecting the entire recording mechanism; chart take-up device; and lifetime cooling fan. **Circle 317 on Reader Service Card.**



Delay Lines
millisec units

FERRANTI ELECTRIC INC., Electronics Division, 95 Madison Ave., Hempstead, N. Y. A new range of acoustic delay lines provide delays up to 5 millisec and operating frequencies up to 1 mc, with temperature coefficients of less than 5 parts per million per deg C. The lines are available in four packages, to any specified delay in the range 20 to 5,000 μsec, with a $\pm$ 4 μsec adjustment available to the user. The packages can be supplied complete with transistor input and output amplifiers. The shorter lines can be supplied with taps at specified positions. **Circle 318 on Reader Service Card.**



Stability Tester
measures drift, f-m

LABORATORY FOR ELECTRONICS, INC., 75 Pitts St., Boston 14, Mass. Model 5009 microwave stability

Ballantine SENSITIVE ELECTRONIC VOLTMETER

Battery Operated

VOLTAGE RANGE:
100 microvolts to 1000 volts rms of a sine wave in 7 decade ranges.

INPUT IMPEDANCE:
2 megohms shunted by 10 mmfd on high ranges and 25 mmfd on low ranges.

FREQUENCY RANGE:
2 cps to 150,000 cps.

ACCURACY:
3% except 5% below 5 cps and above 100,000 cps
and
for any point on meter scale.

MODEL 302C—Price $245.

- Available accessories increase the voltage range from 20 microvolts to 10,000 volts.
- Available precision shunt resistors permit the measurement of AC currents from 10 amperes down to one-tenth of a microampere.
- Features the well-known Ballantine logarithmic voltage and uniform DB scales.
- Battery life over 100 hours.
- Can also be used as a flat pre-amplifier with a maximum gain of 60 DB. Because of the complete absence of AC hum, the amplifier section will be found extremely useful for improving the sensitivity of oscilloscopes.

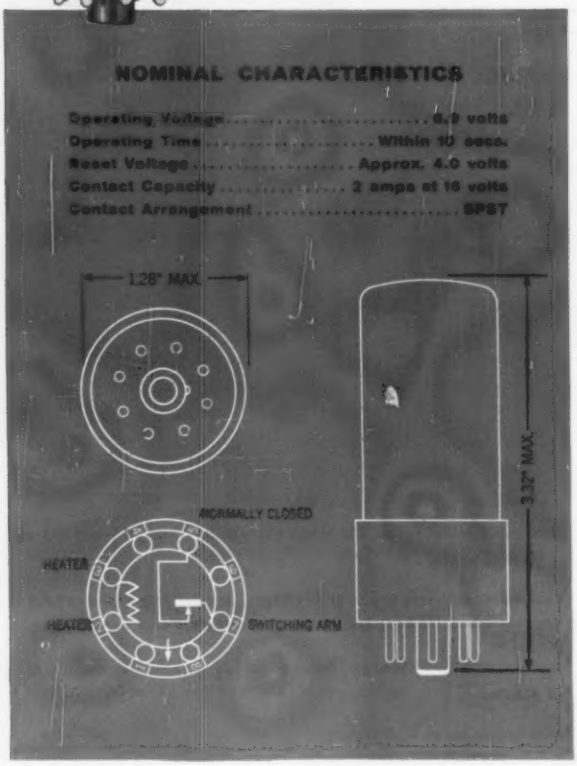
For further information on this and other Ballantine instruments write for our new catalog.

BALLANTINE LABORATORIES, INC.

TUNG-SOL G-127
Sensitive Overvoltage Relay

OPERATES AT 6.9 VOLTS TO LIMITS OF ± 0.2 VOLTS

In addition, the G-127 has a calibration change of only .2 volts over a temperature range of −40° to +80° C . . . resists damage from vibration in a range of 10 to 55 cycles and from shock of 50Gs . . . employs snap action contacts for consistent operation. The G-127 is characteristic of the *precision-in-performance* of the entire line of Tung-Sol thermal relays. Whatever your relay requirement, contact Tung-Sol for complete, confidential engineering assistance.



For additional data write: Electroswitch Division, Tung-Sol Electric Inc., Newark 4, N. J. Sales Offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Tex.; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. Canada: Montreal, P. Q.

TUNG-SOL®

CIRCLE 98 READERS SERVICE CARD

tester measures drift and f-m in frequency bands between 10 mc and 10,800 mc. It will measure these same parameters at 30 mc and 30 kc to 70 kc. All information is presented on two large, easy-to-read meters which are calibrated to read peak f-m deviation in cps and drift in kc. It is composed of two units: a power supply with a plug-in r-f head and an indicator. **Circle 319 on Reader Service Card.**

Power Supply 12-kv unit

Film Capacitors, Inc., 3400 Park Ave., New York 56, N. Y. A 12-kv power supply, model PS 12-T, featuring an oil-filled, hermetically sealed unit incorporating a full-wave voltage-doubler circuit, and rugged IB3-6T tubes, is now available.

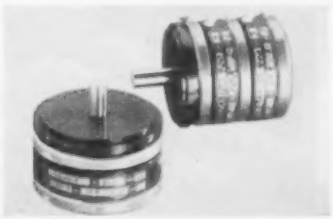
Model PS12-T delivers up to 12,000 v d-c at 1 ma, and up to 1.75 ma at 11,500 v for short periods of time. Output voltage is variable from 0 to 12 kv at rated load by varying input voltage to the separate plate transformer. Regulation from no load to full load is close to 7 percent.

Output ripple is 0.75 percent maximum at rated output. **Circle 320 on Reader Service Card.**

Power Supply high current unit

Electronic Research Associates, Inc., 67 Factory Place, Cedar

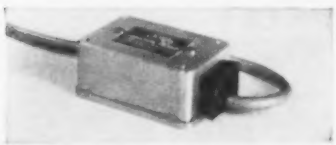
Grove, N. J. Model TR32-2 transistorized power supply is intended for all types of high current laboratory and industrial applications. It features an all-semiconductor design and characteristics include fast transient response, small size and light weight, adjustable regulation control, low ripple content, and independence from line frequency change. **Circle 321 on Reader Service Card.**



Precision Pots high resolution

G. M. Giannini & Co., Inc., 918 East Green St., Pasadena 1, Calif. Built to NAS standards in 1⅞ in. and 1¾ in. sizes, a new line of precision pots can be supplied singly or as externally phaseable ganged units.

Standard resolution for model 1437 (1⅞ in.) is provided as high as 3900 wires, with a resistance range from 100 to 160,000 ohms. Model 1750 (1¾ in.) is available with resolution to 5000 wires, and with a resistance ranging from 100 to 300,000 ohms. Standard linearity range for both units is 0.5 percent to 0.1 percent. **Circle 322 on Reader Service Card.**

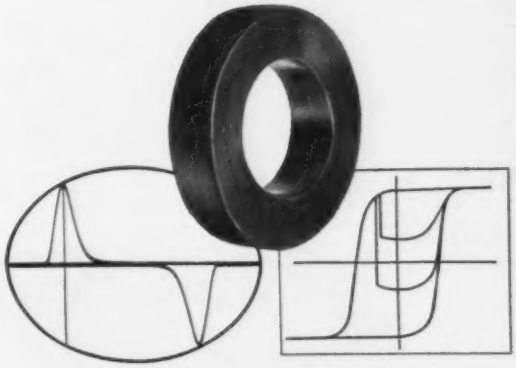


Vibration Pickups high sensitivity

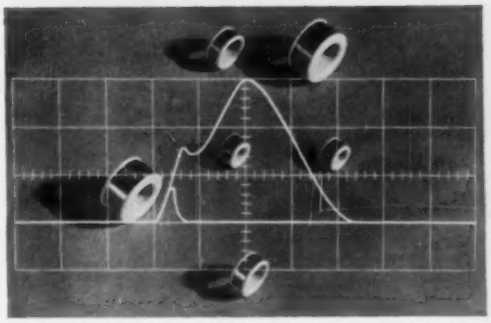
Southwestern Industrial Electronics Co., 2831 Post Oak Road, Houston 19, Texas. Development of a unique magnetic circuit now enables SIE to offer the new TD-Series vibration pickups which combine the temperature stability of

G-L Consistent UNIFORMITY

Tape Wound Cores



Bobbin Cores



Not only G-L but our customers, too, claim consistent uniformity with every G-L Tape Wound Core and Bobbin Core. This consistent uniformity is the result of: an accuracy of control never before achieved in each and every step of the manufacturing process; the use of the highest quality raw materials and new and exclusive manufacturing technologies.

Prove our claims and the claims of our customers. Write, wire, call or teletype us about your requirements and for our technical bulletins.

G-L ELECTRONICS

2921 ADMIRAL WILSON BOULEVARD
CAMDEN 5, NEW JERSEY
WOodlawn 6-2780 TWX 761 Camden, N.J.

New PRECISION FREQUENCY

STATIC INVERTER SUPPLY

INPUT 28V D.C. ± 10%

OUTPUT Nom. 115V ± 2% 400 CPS ± 0.01%
1 ϕ (2- or 3-phase output available)

RATINGS: 30VA 50VA 100VA
Higher ratings available.

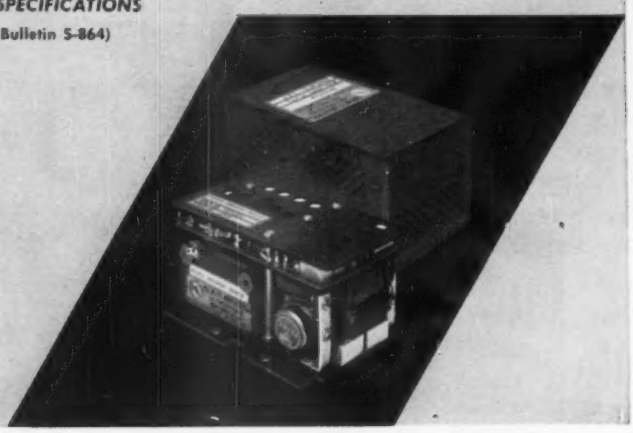
APPLICATION:

For gyro wheel supplies and where precise 400 cycle voltages are required in aircraft, radar and missile computers.

FEATURES:

PRECISION OUTPUT FREQUENCY
RUGGED
EXCELLENT WAVEFORM
SIMPLICITY OF CIRCUITRY
FAST STARTING TIME
GOOD VOLTAGE REGULATION
throughout an adjustable range
ISOLATED CASE DESIGN
HIGH RELIABILITY
VIBRATION ISOLATED
COMPACT
LIGHTWEIGHT
MILITARY SPECIFICATIONS

(Send for Bulletin S-864)



PERFORMANCE SPECIFICATIONS

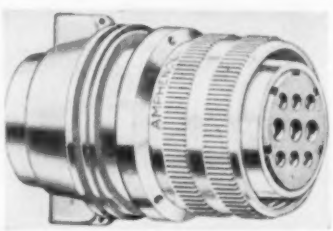
MODEL NUMBERS				
	± .01% CPS	SIS 40311	SIS 40511	SIS 410011
	± .05% CPS	SIS 40315	SIS 40515	SIS 410015
INPUT VOLTAGE		28V DC ± 10%		
MAX. OUTPUT POWER		30VA	50VA	100VA
OUTPUT VOLTAGE		115V AC (Adjustable ± 10%)		
OUTPUT FREQUENCY		400 CPS ± .01% 400 CPS ± .05%		
VOLTAGE REGULATION		±1% For Line Variations ± 2% For Load Variations		
FREQUENCY DISTORTION		3% Maximum At Full Load		
LOAD POWER FACTOR		+0.5 to −0.5 Maximum		
MILITARY SPECS.		MIL-E-5400A & MIL-E-5272A		
AMBIENT TEMPERATURE		−55°C to +71°C when mounted to heat sink		
VIBRATION		20G 10 to 2000 CPS		
UNIT DIMENSIONS		L5" D 2 7/8" H 2 13/16"	L8" D 2 7/8" H 2 13/16"	L10" D 4 1/2" H 2 13/16"
WEIGHT (Approx.)		2 lbs.	3.5 lbs.	5 lbs.

MA **MAGNETIC AMPLIFIERS INC.**
632 TINTON AVENUE • NEW YORK 55, N.Y. • CYPRESS 2-6610
West Coast Division
136 WASHINGTON ST. • EL SEGUNDO, CAL. • OREGON 8-2665

magnetic damping with sensitivity previously available only in fluid damped units. Using completely new design features, TD pickups produce sensitivities of over 300 mv/in./sec. Weighing only 9 oz, five compact models are available with natural frequencies ranging from 1.8 to 5.6 cps and response to 2,500 on undamped models and 1,500 cps on damped units. **Circle 323 on Reader Service Card.**

Rectifiers silicon-cartridge

INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., has available a complete series of hermetically-sealed, high current silicon cartridge-type rectifiers featuring current ratings three to four times greater than those of standard h-v units. Designed for forced-air or liquid cooling, these miniature rectifiers utilize metallized ceramic housings with ferrule-type terminals for insertion into standard 30 ampere fuse clips. They are available in piv ratings of from 1,500 to 16,000 v at rectified d-c output currents ranging from 210 to 360 ma. **Circle 324 on Reader Service Card.**

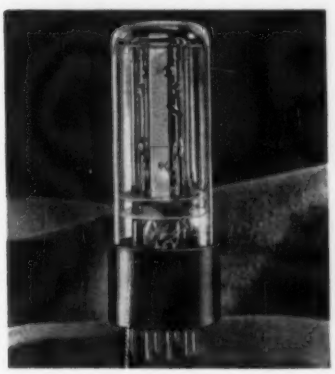


Connectors small and light

AMPHENOL ELECTRONICS CORP., Chicago 50, Ill. MIL-C-5015C "E"

construction MS connectors, trade named Stub E, are now available. Claimed to be the smallest and lightest made, they fully conform to the environmental-resistance requirements of the cited specification.

Available in shell types 3100, 3101, 3102 and 3106, the connectors incorporate standard MS insert configurations. Features include a fully unitized rear grommet and cable clamp which can be quickly assembled and disassembled, prefilled contact solder pockets for instant, easy soldering, and the weight-saving, space-saving shell design.

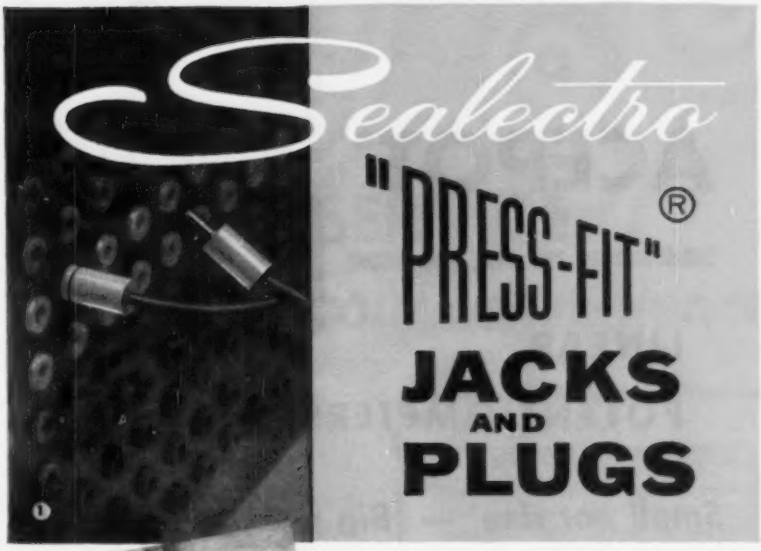


L-F Crystal Units in glass holders

Reeves-Hoffman Div., Dynamics Corp. of America, Carlisle, Pa. Precision low-frequency crystal units in glass holders, type RHG-DP, are built to provide more accurate frequency control in the audio range of from 1 to 15 kc. They may be used in aircraft navigation equipment, telephone carrier systems, communication systems and test equipment. Components are hermetically sealed in glass bulbs (T 5½ with noval base), assuring internal cleanliness and reliable evacuation. **Circle 325 on Reader Service Card.**

Power Supply transistorized

Westron Semiconductors, Inc., 2312 So. Robertson Blvd., Los Angeles 34, Calif., has available a



Only Sealectro — originator, pioneer and leader in Teflon* terminals — has a wide selection of "Press-Fit" jacks, plugs and connectors. And in color, too, for coding purposes. The one-piece construction does away with screws, nuts, washers, lockwashers, to save labor and space alike. Just "Press-Fit" — that's it!

So, for miniature and sub-miniature jacks, plugs and connectors, insist on *genuine* Sealectro "Press-Fit".

1. Ideal jacks and mating plugs for patch-cord boards. Jacks mount directly in metal, eliminating breakable plastic panels. As many as 14,400 "Press-Fit" jacks have been mounted on single metal plate, for computer assemblies!
2. Handy breakaway connectors. Mated male and female members. Mount directly in metal. Widely used for plug-in components and circuitry.
3. Outstanding choice of miniature jacks. Stamped or machined beryllium-copper contact members. Bull-dog grip!
4. And tiny! These subminiature test-point jacks take standard test probes.

for that "KNOW-HOW"...

Be sure you have the "Press-Fit" catalog in your reference file. Then get "TERMINALOGY" — jam-full of practical data — right along by mail. Write on business stationery.

*Reg. Trademark of E. I. Du Pont de Nemours & Co., Inc.

Sealectro CORPORATION
610 FAYETTE AVENUE • MAMARONECK, N. Y.

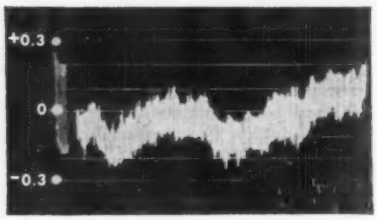
ACEPOT®

SUB-MINIATURE, PRECISION, WIRE-WOUND

LINEAR POTENTIOMETERS

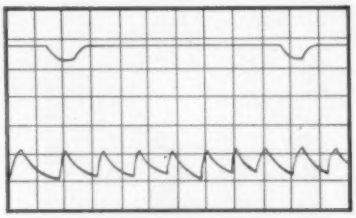
Small pot size — Big pot performance

Only ½" in diameter, the ACEPOT excels in a combination of all around top performance characteristics comparable to larger units. For example, these precision units feature ± 2% resistance tolerance and ± 0.3% independent linearity. Every potentiometer is completely sealed against sand, dust and foreign matter to avoid abrasive action between moving parts. All materials and metals are treated for maximum resistance to salt spray, corrosion, humidity and conform to shock and vibration tests. ACEPOTS are designed and assembled MIL-A-8625A, QQ-M-1512, JAN-T-152, MIL-E-5272A, MIL-R-19A, NAS-710 and MIL-R-19518 (ships).



ACEPOT LINEARITY TEST

Plot of voltage ratio error versus rotation illustrates linearity to better than ± 0.3%.



ACEPOT RESOLUTION TEST

Section of oscillograph trace of electrical resolution shows voltage change for each turn of wire.

ACE offers a wide variety of linear and nonlinear precision, wirewound potentiometers in standard, special and AIA sizes. Custom designs to meet special requirements can be made available on short lead time. Call, write or teletype Dept. F, ACE ELECTRONICS ASSOCIATES, INC., 99 Dover Street, Somerville, Mass., SOmerset 6-5130, TWX SMVL-181.

ACEPOT®
ACETRIM®
ACESET®
ACEOHM®
ACE ELECTRONICS ASSOCIATES, INC.

transistorized power supply for two-way communication gear. It comes in two models, one for 30 w r-f power, and another for 60 w r-f power. This unit replaces the vibrator in the present existing equipment and can be installed in minutes. The power supply makes possible transmission and reception at ⅛ of the present initial cost of transistorized power supplies now available on the market, according to the company. **Circle 326 on Reader Service Card.**

Quartz Crystals l-f devices

Monitor Products Co., 815 Fremont Ave., South Pasadena, Calif., announces new low frequency quartz crystals to meet high vibration requirements. The MC-13/U crystals are fully tested from 2 to 2,000 cps vibration. Typical tolerance is ± .012 percent from − 40 C to + 70 C. **Circle 327 on Reader Service Card.**

Crystal Oven controls temperature

Bliley Electric Co., Union Station Building, Erie, Pa., has available a new crystal oven which maintains temperature within ± 0.1 C. The temperature control

Get out your pencil and . . .

Help yourself to
electronics' READER SERVICE
it's free–it's easy–it's for your convenience

Each Advertisement and New Product item is numbered.

For more information, simply . . .

(1) Circle number on postpaid card below that corresponds to number at the bottom of Advertisement, or New Product item.

(2) Print your name, title, address, and firm name carefully. It is impossible to process cards that are not readable.

***FOR SPECIFIC ITEMS IN MULTI-PRODUCT ADVERTISEMENTS**

Please indicate in box in postcard marked with asterisk (*) specific item(s) in ad in which you are interested. Please write ad circle number(s) and specific product(s) on which you want more information.

Additional postage MUST be added to cards for all FOREIGN MAILINGS

An occasional Advertisement cannot be numbered for the READER SERVICE CARD due to lack of space and must be indicated by writing the Advertisers' name in the space at the bottom of the card...

MAY 9·58
CARD EXPIRES
JUL 9,58

electronics • ENGINEERING EDITION • READER SERVICE CARD

(NAME) _____ (POSITION) _____

(COMPANY) _____ (ADDRESS) _____

CIRCLE THESE NUMBERS ONLY WHEN YOU ARE INTERESTED IN ALL ITEMS SHOWN OR DESCRIBED

Circle No.	Product	*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19								
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MEMO:

NEW PRODUCTS RELEASES

TO: ALL MANUFACTURERS

FROM: electronics

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oven when used with a Bliley type BG7 crystal at 1,000 kc provides a frequency stability of 4 parts in 100 million per day under ambient conditions at 25 C ± 15 C. The oven heater rating is 115 v a-c, 10 w. Bulletin 508 is available. **Circle 328 on Reader Service Card.**

Oscilloscopes d-c to 200 kc

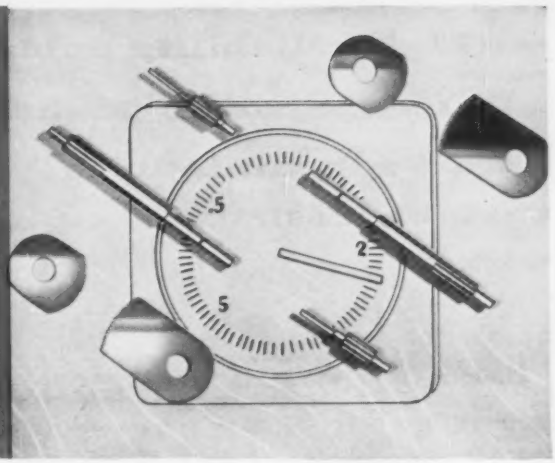
HEWLETT-PACKARD CO., 275 Page Mill Road, Palo Alto, Calif. The 120A (cabinet mount) and 120 AR (rack mount) are d-c to 200 kc oscilloscopes with automatic triggering and simplified controls. They have a sweep speed range of 1 μsec/cm to 0.5 sec/cm. Included is a times-5 sweep expansion on all ranges, with vernier for continuous control. Fifteen calibrated sweeps are provided, in 1-2-5 sequence. Instantaneous, automatic synchronizing is provided on any internal or external voltage; scopes may also be triggered by line voltage. Calibrated identical bandwidth vertical and horizontal amplifiers provide convenient phase measurement. **Circle 329 on Reader Service Card.**

Trimmer Pots minimalized

CARTER MFG. CORP., 23 Washington St., Hudson, Mass., has available two new minimalized trimmer

20 TO 200 D.P.

SEND YOUR PRINTS FOR QUOTATION



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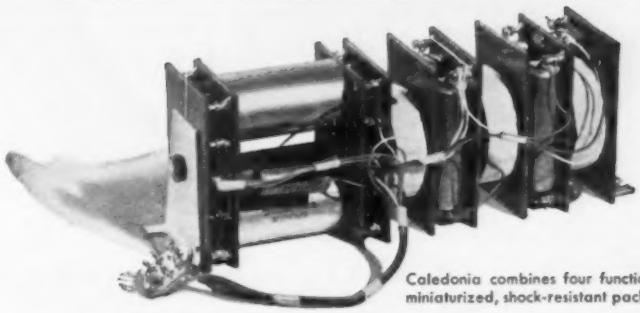


Caledonia combines four functions in miniaturized, shock-resistant package.

Electronics today is partly packaging

PROBLEM: Design a small (50 cubic in.) and light (3¾ lbs.) unit that contains:
1. a positive d.c. pulse selector
2. a negative d.c. pulse selector
3. a high level 60 cps band pass filter
4. a 400 cps detector circuit

(all with tight tolerances, naturally).

Design it to operate within the usual military environmental conditions, including high vibration and shock.

SOLUTION: We assembled the components shishkabob style. Then mounted the

kabob in a metal case filled with an epoxy foam compound to hold the parts in a firm cushion.

TIME ELAPSED: From original assignment, through design to volume production—two months.

If such quick, dependable assistance in design and production can make your work more effective, we'll be glad to hear from you. We offer experience, good production facilities, and a recognized quality record.

CALEDONIA

ELECTRONICS AND TRANSFORMER CORPORATION

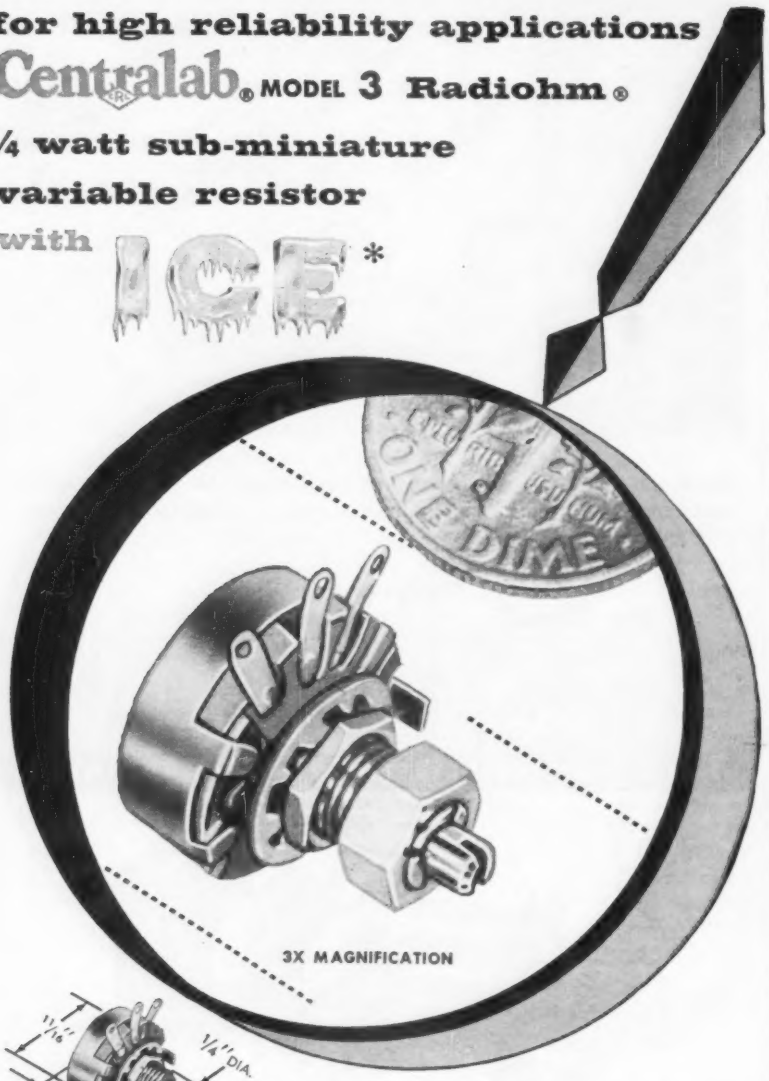
Dept. E-5, Caledonia, N.Y. • *In Canada:* Hackbusch Electronics, Ltd., 23 Primrose Ave., Toronto 4, Ont.

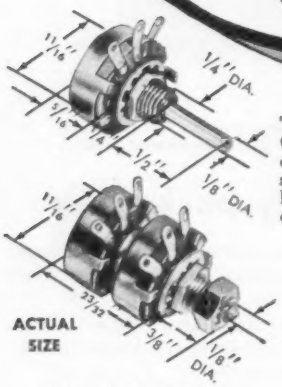
for high reliability applications

Centralab® MODEL 3 Radiohm®

¼ watt sub-miniature variable resistor

with ICE*





Your local Centralab distributor carries a wide variety of these units in stock. Ask him for Model JP and JL controls—as listed in Catalog 30.

The Model 3 utilizes Centralab's ICE* (Interfused Composition Element) to provide exceptional heat dissipation and electrical stability under the most severe operating conditions. It is recommended for high temperature operation in both military and commercial equipment.

- Will meet MIL-R-94B resistance change requirements under *twice* its rated load.
- Meets or exceeds MIL-R-94B requirements for moisture resistance, insulation resistance, thermal cycling, etc.
- Completely enclosed case can be sealed or potted.
- Resistance range: 200 ohms to 2.5 megohms, linear taper and 5000 ohms to 2.5 megohms 10% log audio taper.

Write for Technical Bulletin EP-63 containing detailed specifications or contact your Centralab representative.

Centralab

8-5809

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In Canada: 804 Mt. Pleasant Rd. • Toronto, Ontario

VARIABLE RESISTORS • PACKAGED ELECTRONIC CIRCUITS • ELECTRONIC SWITCHES
CERAMIC CAPACITORS • ENGINEERED CERAMICS • SEMI-CONDUCTOR PRODUCTS

potentiometers in 15 standard resistance values from 47 ohms to 10,000 ohms. All values are manufactured with 20 ppm resistance wire and can dissipate ½ w to 100 C (derated to zero at 150 C) for a period of 1,000 hr.

Type 101F may be mounted by its leads alone, in a fuse clip or a 0.290 in. hole. Type 101G is supplied with a nut for mounting in a 5/16 in. hole and a nut for locking the shaft against rotation. **Circle 330 on Reader Service Card.**

Decade Amplifier transistorized

Zacharias Electronics Corp., P.O. Box 172, Livingston, N. J. Model 40-A transistor decade amplifier lends itself to a wide variety of fixed or portable applications. The amplifier noise figure is made independent of the magnitude of the driving impedance through the use of a vacuum tube at the input stage. The input impedance, in excess of 10 megohms, minimizes loading of circuits under test. The constant 600 ohm output impedance is useful for driving many passive networks. A gain of 10 or 100 is available over the 2 to 1,000,000 cps range throughout the 800 hr life of the batteries, with an accuracy of ± 0.2 db from 10 cps to 300,000 cps and ± 1 db from 5 to 500,000 cps. Maximum out-

put is 3 v rms or 1 mv. Circle 331 on Reader Service Card.

Crest Voltmeter switch controlled

Sensitive Research Instrument Corp., 310 Main St., New Rochelle, N. Y., has available a new crest voltmeter for measuring positive and negative peaks and rms. All three functions are measured by means of switching. Choice of pulse response from 10 to 99 or 100 and above is also by switch.

Range of the basic instrument is 0.1 kv. External multipliers are available up to 100 kv. Accuracy is 1 percent of full scale for rms and for peaks of 100 per sec and faster on FAST position or, 10 to 99 per sec on SLOW position. Input impedance is as follows: rms—10,000 megohms and 25 $\mu\mu$f; positive and negative peaks—10,000 megohms and 15 $\mu\mu$f. Circle 332 on Reader Service Card.

Circuit Breaker subminiaturized

Heinemann Electric Co., 455 Plum St., Trenton 2, N. J. Model SM3 is a hermetically sealed subminiaturized circuit breaker. A series-overload breaker, it is designed for operation at 110 v at

RECTANGULAR & SQUARE
2- and 4-Gun Tubes
. . . exclusive with ETC, give raster areas equal to 7" round tubes.

***Plug-in* CALI-MARKER®**
Calibrator & Time-Mark Generator
The first compact, plug-in unit of its kind. Combines a stable, square-wave calibrator and a crystal-controlled time-mark generator. Interchangeable with a second plug-in sweep generator.

***Plug-in* PRE-AMPLIFIERS**
Choice of 5 types for each channel. Matches sensitivity and response requirements from 50 mv/cm to 50 μv/cm, dc to 50 kc to 5 mc. Any combination of pre-amplifiers may be used simultaneously on all channels.

***Plug-in* SWEEP GENERATORS**
One or two identical plug-in sweeps may be used on each instrument for common or separate calibrated time bases as needed. Second sweep interchangeable with Cali-Marker.

Announcing
THE WORLD'S MOST VERSATILE OSCILLOSCOPES!
with Plug-ins for All Needed Ranges . . .
All Needed Features . . . No Obsolescence.

2- and 4-Channel Types
Models K-270 and K-470 . . .
Display multiple, high-speed signals *without* switching. From DC to 5 megacycle bandwidths.

Here is true multi-channel oscillography with features, performance, and prices "tailored" to your exact needs. Versatile plug-in pre-amplifiers, sweeps, and marker-calibrator circuits need be purchased only *as* you need them . . . when you need them. No worries of having "too much" scope now . . . not enough scope flexibility a few years later.

From simple one-channel monitoring jobs to difficult medical, biophysical and low-level strain gauge recording involving two, three or four channels, you'll find no jobs too small or few too large for these versatile ETC instruments.

Write for detailed specifications and prices.

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electronic tube
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Glass-to-metal sealed ELAPSED TIME indicators. Compact, low cost, tamper-proof. Standard ASA/MIL dimensions, 2½" and 3½" sizes. Easy to read standard size counter registers 1/10 hour steps to 9999.9 or hour steps to 99999. Hermetically sealed. Shielded. Starts, operates continuously from −55°C to +85°C. For 110-125 or 220-250 volts 60 cycle A.C. Bulletin on request. Marion Electrical Instrument Co., Manchester, N. H., U. S. A.

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EXTRA MONEY
I'm earning in Mobile-Radio Maintenance!

I couldn't set aside from my engineer's salary enough money to send the kids through college. So when I learned of the boom in mobile-radio I decided to start my own part-time business. Now my income from mobile-radio maintenance goes into a "college bank account."

This can be your story, too. Send coupon for your free copy of "HOW TO MAKE MONEY IN MOBILE-RADIO MAINTENANCE." Published by Lampkin Laboratories, Inc., manufacturers of the 105-B Micrometer Frequency Meter and 205-A FM Modulation Meter.

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either 60 or 400 cps, or for 50 v d-c. It is available in ratings from 50 ma to 10 amperes. A choice of two time delay curves is offered, for fast or slow overload response, and the breaker is also available with instantaneous-trip response.

Since the SM3 combines magnetic actuation with hydraulic time delay, its current capacity and must-trip points are free from ambient temperature effects. The breaker will maintain its 125-percent must-trip point from − 65 to + 125 C. **Circle 333 on Reader Service Card.**

Molding Compounds for cable breakouts

Coast Pro-Seal and Mfg. Co., 2235 Beverly Blvd., Los Angeles, Calif. Two non-Thiokol permanently flexible cable molding compounds with virtually no cold flow at room temperature have been developed. Designated as Pro-Seal 787 and 788, the compounds are designed for use on "Y" breakouts and "multiple finger" breakouts.

The properties of the two compounds have been prepared to withstand prolonged exposure to 300 F and shorter periods of 325 F. They have excellent resistance to fuels, oils, water and other liquids encountered in missiles and aircraft. **Circle 334 on Reader Service Card.**

Synthetic Sapphire in large shapes

Linde Co., 30 E. 42nd St., New York 17, N. Y., has available single crystal sapphire in large shapes,

CABLE CLIPS
★ of all Nylon for severe conditions
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WECKESSER

molded Black Nylon SCREWS and NUTS
★ Acid resistant
★ Need no insulation
★ Can't rust
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uniformity . . .
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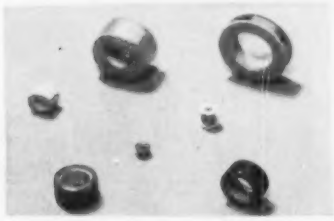
such as for windows, also in the form of rods, domes, balls, slugs and many special shapes. The material is transparent, has good dielectric characteristics, a high melting point, strength at elevated temperatures, extreme hardness and excellent infrared and ultraviolet transmission characteristics. Uses include output windows for high power klystrons, magnetrons, traveling wave and TR tubes. **Circle 335 on Reader Service Card.**

Load Control Relay
watt-sensitive

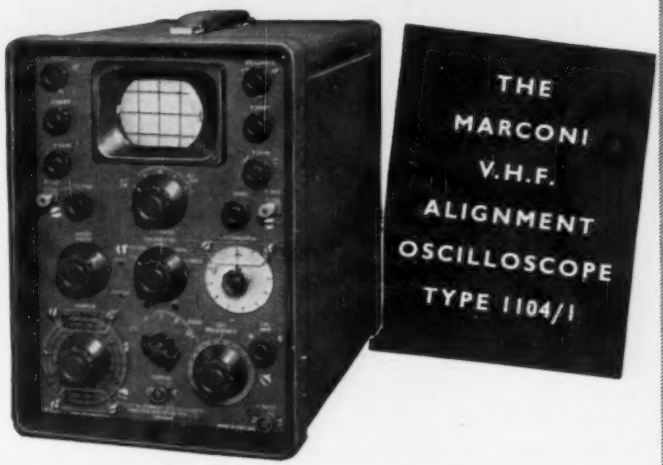
MACHINERY ELECTRIFICATION, INC., 56 Hudson St., Northboro, Mass. The MEK-2134 load control relay was designed for use with three-phase induction motors. Since any change in motor loading requires a change in input power (watts) the MEK-2134 series controls offer advantages over devices which respond only to changes in current (amperes). **Circle 336 on Reader Service Card.**



Bobbin Cores
use ultrathin tape

DYNACOR, INC., 10431 Metropolitan Ave., Kensington, Md. Bobbin cores using ultrathin tape offer

Dynamic Analysis of Frequency Response



A combined sweep generator and c.r.o. suitable for v.h.f., i.f., and v.f. response analysis

FEATURES

• Sweep width variable up to 10 Mc/s • Crystal controlled fixed frequency-marker pips • Calibrated continuously variable frequency marker • High output • Sensitive Y amplifier • Calibrated output attenuator

APPLICATIONS:

Alignment and response measurement on television and f.m. v.h.f. receivers; v.s.w.r. of feeder lines; matching feeders to antennas; direct tests on i.f. and r.f. transformers; use as a general purpose oscilloscope.

ABRIDGED SPECIFICATION

Frequency Range: R.F. 50-75 Mc, 75-115 Mc, 150-216 Mc; I.F. 10-45 Mc; V.F. 5 kc-10 Mc.
Output Range: 100 μV-100 mV.
Sweep Width: variable from 500 kc to 10 Mc.
Calibration: continuously variable marker oscillator provides pip corresponding to known frequency, 3-frequency crystal oscillator generates pips at intervals of 5.0, 1.0 and 0.5 Mc.
Time Base: 12 to 50 cps for sweep, 12 cps to 10 kc for general purpose.
TUBES: 5Z4G, 12AT7, 12AU7, 12AX7, 6C4, 6AK5, 6AK6.

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GREATER...

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• ACCURACY

• Multi-column

• Smaller size

• Hermetically sealed

Cox and Stevens

LOAD CELLS

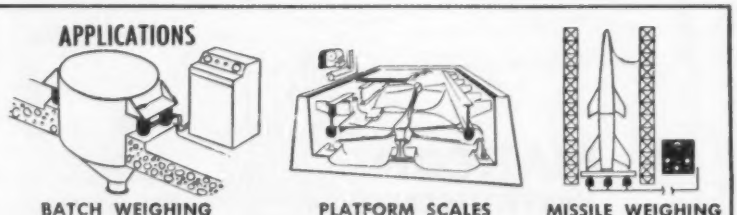
For greater accuracy and stability in all types of weight and force measurement, specify new Cox and Stevens hermetically sealed load cells. Sixteen strain gages in multi-column design provide up to 250% greater output, improved stability and better uniformity between cells. Capacities range from 500 to 200,000 lbs. All cells with 30 feet of special moisture- and chemical-resistant cable in stainless steel jacket.

Cox and Stevens' fifteen years experience in designing and manufacturing load cells, plus dead weight testing facilities which make possible calibration to higher accuracies, assure maximum reliability. Write for technical bulletins.

TYPICAL SPECIFICATIONS

1. Recommended Input:	20 volts
2. Change in Output, No Load to Full Load:	1.750 ± .1% millivolts/volt input
3. No Load Output:	± .25% of full load output
4. Output Linearity:	0 to + .20% of full load output
5. Temperature Effect on Cell Output (15 to 115°F):	± .0008%/°F of output at applied load
6. Temperature Effect on No Load Output (15 to 115°F):	± .0013%/°F of full load output
7. Input Impedance at 75°F:	450 ± 1 ohms
8. Allowable Load:	225% of rated capacity
9. Deflection Under Rated Load:	Less than 0.003"

APPLICATIONS



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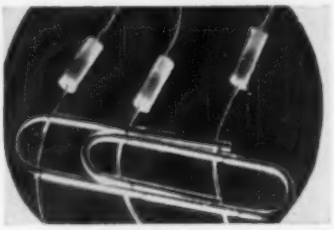
greater uniformity and reliability. They should interest designers using magnetic core logic for computer, counter and control circuits. The bobbin cores find ideal application in critical magnetic shift register, switching transformer and other logic circuits which require the utmost uniformity in switching time and signal-to-noise ratio. **Circle 337 on Reader Service Card.**



Capacitors microminiature

General Electric Co., Schenectady 5, N. Y., announces a new line of slug-type microminiature Tantalytic capacitors. These polar units permit higher microfarad ratings than can be obtained by wire-type units with the same case size. The capacitors are normally enclosed in a Mylar sleeve which affords excellent insulating qualities.

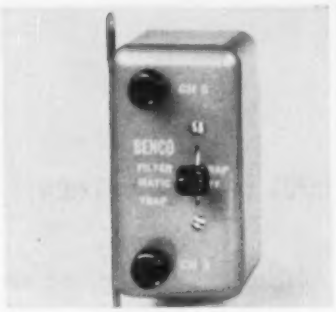
The new capacitors are designed for low voltage transistor applications—such as hearing aids—where high microfarad values are required in extremely small spaces. **Circle 338 on Reader Service Card.**

Beam Power Tube high perveance

Radio Corp. of America, Harrison, N. J., has introduced the 7094 high perveance beam power

tube with high power gain. In continuous-wave service it can be operated with 500 w input (intermittent commercial and amateur service) at frequencies up to 60 mc and with reduced input up to 175 mc. It has a maximum plate dissipation of 125 w (ICAS) in modulator and c-w service.

The new tube can be operated with relatively low plate voltage to give large power output with small driving power. **Circle 339 on Reader Service Card.**



Filter Trap in two models

BENCO TELEVISION ASSOCIATES LTD., 27 Taber Road, Rexdale, Ontario, Canada, announces development of their new improved adjacent channel interference filter trap, known as the Filter Matic. The unit incorporates Hi-Q traps as well as band pass filters. It is available in single and dual models. **Circle 340 on Reader Service Card.**

Transformer miniature unit

ADVANCE INDUSTRIES, INC., 640 Memorial Drive, Cambridge, Mass., has available a new miniature, asymmetric, laminar power toroid for use in either airborne or ground equipment.

This 25-watt, 400-cycle transformer is available in voltage rat-

real RMS v.t.v.m.

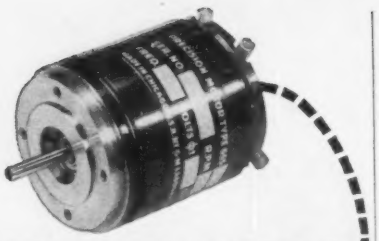
1/2% ABSOLUTE ACCURACY

The new Millivac MV-32A precision RMS VTVM is a "transfer" voltmeter in which the unknown voltage is carefully matched by a very accurate calibration signal. Thus, all measuring errors created by the range attenuator, AC amplifier, rectifier and indicating instrument are completely eliminated.

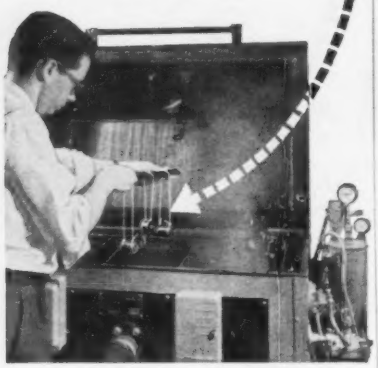
This new precision meter should not be confused with the so-called "true" RMS voltmeters which use biased diodes or other "synthetic" RMS-sensitive circuitry. This is a real RMS voltmeter, incorporating an electronically protected thermo-couple as its RMS-responsive meter-rectifier.

MILLIVAC
INSTRUMENTS
Division of COHU Electronics, Inc.
BOX 997, SCHENECTADY, N.Y.

TOMORROW IS OUR YESTERDAY



STIFF DOSE OF SALT



Exposure . . . to the equivalent of a stiff sea spray . . . on a hot, humid day—one more test the G-M Servos take in stride.

Not just a promise—but a tested fact.

G-M Servo Motors are built to deliver the ultimate in performance. The salt spray test shown above is just one of a battery of tortures designed to prove G-M Servos under all extremes of humidity, temperature, altitude, vibration and salt spray.

At G-M "Designed to Meet Mil. Environmental Specifications" is backed by production testing that does just that!

4 GOOD REASONS WHY G-M SERVO MOTORS SERVE YOU BEST!

1. G-M Servo Motors are available in standard sizes.
2. Standard G-M Servo Motors can also be modified to meet specific requirements.
3. Creative engineering in designing special servo motors with special characteristics.
4. Fast production—better service.

Write Now for information, or send for complete G-M charts and specifications. No obligation, of course.

GM

G-M Servo Motors

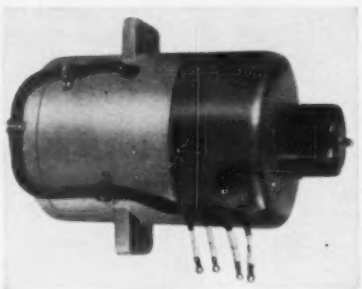
manufactured by the Components Division of

G-M LABORATORIES INC.

4336 N. Knox Avenue • Chicago 41

CIRCLE 114 READERS SERVICE CARD

ings up to 1,000 v. Extreme reliability with very small size and low heat rise are its principal design features. The unit is capable of meeting MIL-T-27 requirements. **Circle 341 on Reader Service Card.**



Rotary Converter changes d-c to a-c

KATO ENGINEERING CO., 1415 First Ave., Mankato, Minn. This rotary converter can be mounted easily in a vertical position as a component of test equipment, on boats or ground mobile equipment which are supplied only with d-c and must have a small source of a-c.

The unit is 11¼ in. tall with a diameter of 7⅛ in. It weighs 65 lb.

Precise 60 cps output frequency is maintained within a fraction of a cycle as the attached speed governor holds the speed at 3,600 rpm. Another interesting feature is that the unit is both fungus proof and corrosion proof. **Circle 342 on Reader Service Card.**

Shielded Mount for 2K25 klystron

NARDA MICROWAVE CORP., Mineola, N. Y., announces a completely enclosed and shielded tube mount

now

you can wind your filter coils

WITHOUT CORE ADJUSTMENTS

on

pre-adjusted filter cores

- guaranteed effective permeabilities within ±3%, ±2% or ±1% of specifications, instead of usual 10% to 50% spread
- measured, adjusted and grouped for magnetic characteristics at the factory
- a complete line of pot-type ferrite cores from ⅝" to 1¾" diameter, with bobbins and hardware for each size
- available in quantity to manufacturers of communications, telemetering and computer equipment

There's Nothing Else Even Remotely Like These Pre-Adjusted Potcores

by **FXC**

Write for literature describing standard sizes available from stock, exact permeability values, and number of turns required for any given inductance.

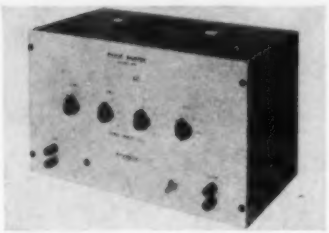
FERROXCUBE CORPORATION OF AMERICA

50 East Bridge Street, Saugerties, New York

CIRCLE 115 READERS SERVICE CARD

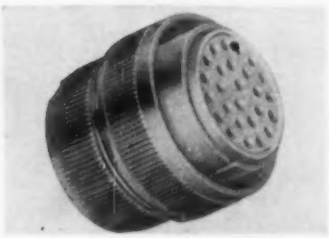
for the 2K25/723AB klystron in 1 by ½ wave-guide. Providing the correct impedance match for maximum power output, model 980B mount permits the klystron shell to be operated at potentials above ground, without danger of shock.

Internal wiring is readily accessible and leads are brought through Narda-iron, which is a dissipative plastic that will not chip or shatter due to mechanical shock. **Circle 343 on Reader Service Card.**



Phase Shifter
0.1 deg accuracy

Dytronics Co., P.O. Box 3676, Columbus 14, Ohio. Model 440 phase shifter uses precision R-C elements in the basic phase determining networks. Features include unity gain independent of phase setting and the direct digital setting of phase angle. Input impedance is 200 K and output impedance is 500 ohms. **Circle 344 on Reader Service Card.**

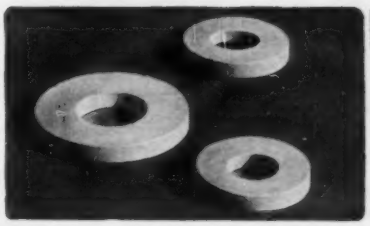


Connectors
meet MIL specs

Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif. The new EX line of connectors, resistant to heat and vibration and sealed for use at extreme altitudes, is announced.

EX connectors meet all require-

NEW NYLON PARTS from GRC



Economically mass produced on fully automatic, patented machines, these stock GRC nylon parts are available in many sizes and types. GRC uses single cavity techniques, molds in one automatic cycle, gets accurate, uniform parts, ready for immediate use.

These advantages, these economies, apply too on parts made to exact specifications . . . in quantities of 50,000 to many millions. Write for bulletin describing GRC's unique methods for injection molding small plastic parts or send prints for quotation. . Ask about our zinc alloy die castings, too!

Maximum size: 1¼" long, .03 oz. No size too small

Write, wire, phone NOW for detailed spec. sheets and prices.

GRC NYLON WASHERS

Molded • Uniform • Accurate

Used as insulators, antifriction bearings, guides and spacers . . . well suited to shock load applications . . . ideal in a variety of applications . . .

These GRC nylon washers have built-in electrical insulating properties . . . natural elasticity and resiliency . . . are non-corrosive, non-magnetic, chemical resistant . . . conform to irregular surfaces, seal, dampen vibration, prevent galling under screw heads.

Available from stock in 5 sizes, from #4 thru ¼". Many others also from stock in a variety of inside and outside diameters and thicknesses.

GRIES

GRIES REPRODUCER CORP.

World's Foremost Producer of Small Die Castings

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CIRCLE 116 READERS SERVICE CARD

DISTORTION METER

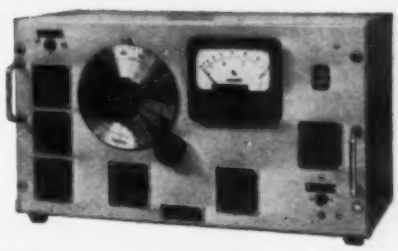
Type **BKF5**

FUNDAMENTAL FREQUENCY RANGE: 20 cps to 20 kc/s

DISTORTION FREQUENCY RANGE: 20 cps to 60 kc/s

FULL SCALE DEFLECTIONS: 0.5% to 100% distortion

INPUT IMPEDANCE: 200 Kilohms



Total distortion, harmonics, and hum measured separately. Meter readings are all r.m.s. values. This instrument makes distortion measurements easy, fast and dependable.

RADIOMETER

72 Emdrupvej, Copenhagen NV, Denmark

Represented in Canada by

BACH-SIMPSON • London/Ontario

Represented in the United States by

WELWYN INT. INC. • 3355 Edgecliff Terrace, Cleveland 11, Ohio

CIRCLE 117 READERS SERVICE CARD

NOW! GO—NO GO—COMPARATIVE MEASUREMENTS AT A GLANCE

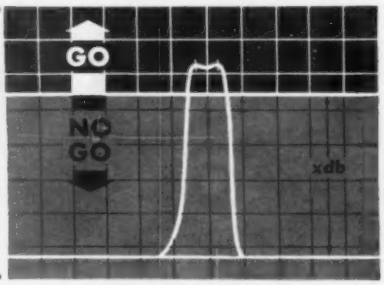
For Quality Control and Production Tests From DC to 250 MC!

NEW HIGH SPEED COAXIAL SWITCH

APPLICATIONS:

Audio — Video — Intermediate — R.F. Circuitry — Passive Networks — Vacuum Tubes — Diodes — Transistors — Etc.

Permits Dual Scope Presentations— Reference and Test



An oscilloscope presentation of a typical Amplifier in Production Test.

$250.00 F.O.B. PLANT Model FD-30*

Frequency range of coaxial circuit is from DC to 250 MC with a VSWR of less than 1.1 at 50 or 75 ohms impedance. Switch contacts "Mercury-Wetted" with an adjustable switch rate of 30, 15 or 10 cps.

For further information on Applications and Specifications write to:

JERROLD

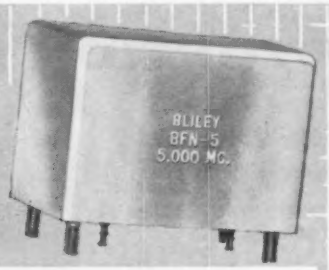
ELECTRONICS CORPORATION, Dept. TED-15
Philadelphia, Pa.

*Specify 50 ohm or 75 ohm impedance

CIRCLE 118 READERS SERVICE CARD

NEW

Bliley



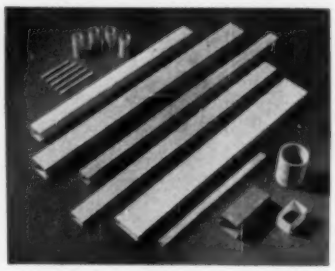
CRYSTAL FILTER NETWORKS

AT STANDARD FREQUENCIES
5 mc - 10.7 mc - 13 mc

BLILEY FILTER NETWORKS ARE NOW AVAILABLE IN THREE STANDARD DESIGNS WITH CHARACTERISTICS SELECTED FOR GENERAL APPLICATION IN COMMUNICATIONS SYSTEMS. ESPECIALLY SUITABLE FOR USE IN SSB AND MINIATURIZED EQUIPMENT, AS WELL AS HIGH SHOCK AND VIBRATION MILITARY APPLICATIONS. FOR CUSTOM APPLICATION, BLILEY WILL DESIGN FILTER NETWORKS OVER THE RANGE 2 mc TO 20 mc. REQUEST BULLETIN #509.

Bliley **BLILEY ELECTRIC COMPANY**
UNION STATION BUILDING • ERIE, PENNSYLVANIA

ments of MIL-C-5015 and MIL-E-5272. They may be operated continuously at temperatures up to 325 F, and maintain the sealing characteristics necessary to prevent voltage flashover at high altitudes. **Circle 345 on Reader Service Card.**



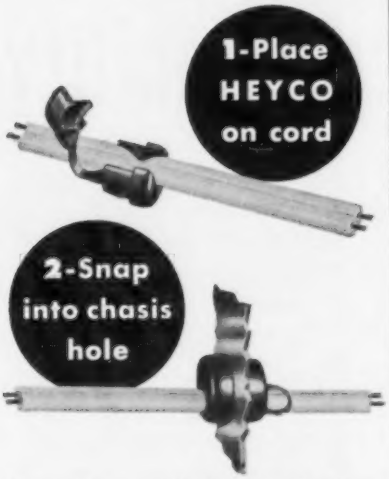
Core Tubes high temperature

SILICONE INSULATION, INC., 1383 Seabury Ave., Bronx 61, N. Y. Rectangular and round high temperature core tubes or coil forms without flanges in almost any size are available. Class H tubes are of laminated silicone glass cloth. They are designed to meet the requirements of military specifications MIL-E-917B for electrical power equipment and MIL-E-16400A for electronic equipment. Class B tubes are of laminated polyester glass cloth or laminated epoxy glass cloth. **Circle 346 on Reader Service Card.**

Gas Noise Source for shf uses

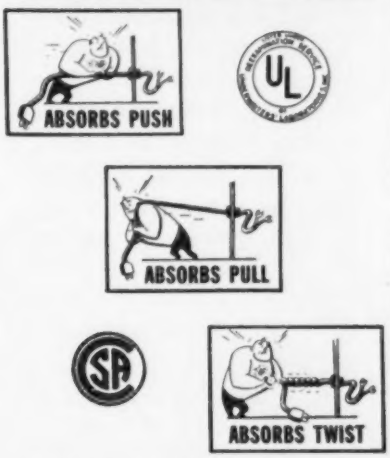
BENDIX AVIATION CORP., Red Bank Division, Eatontown, N. J. Type TD-22 gas noise source tube is designed for use in super high frequency measurements. It is

Protect the life line of your electrical products with Nylon HEYCO Strain Relief Bushings



Anchor & Insulate power supply cords

SAVE TIME...
...SAVE MONEY



Send for samples to fit your wire, today!

HEYMAN
MANUFACTURING COMPANY
KENILWORTH 15, NEW JERSEY

HEYCO

CIRCLE 120 READERS SERVICE CARD

constructed for use with a 90 deg H-plane mount in RG/48U waveguide to provide noise in the 7.6-11.5 cm waveband. When used in the suggested mount assembly it functions essentially as an untuned noise generator over the recommended transmission bandwidth of the mount.

Typical applications for the tube are: radio receiver calibration, radiometer, microwave radio relay, radio telescope reference and noise measurement standard. **Circle 347 on Reader Service Card.**

Digital Voltmeter transistorized

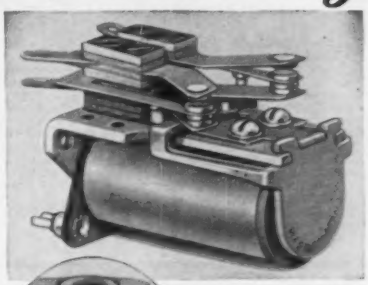
Ransom Research, 323 W. 7th St., San Pedro, Calif. The DVM-1 digital voltmeter may be set for full scale readings of plus 10, 100 or 1,000 v or minus 10, 100 or 1,000 v and measures voltages to a full-scale accuracy of better than 0.5 percent.

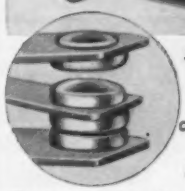
It operates from a 117-v a-c source (20 w) and consists of transistorized computer elements including a precision digital-to-analog converter, comparator, logic and a reference power supply, which is held to an accuracy of better than 0.1 percent. **Circle 348 on Reader Service Card.**

Converters voltage to digital

Adage, Inc., 292 Main St., Cambridge 42, Mass, announces Voldi-

HEAVY DUTY MINIATURE RELAYS for Industrial *Reliability*





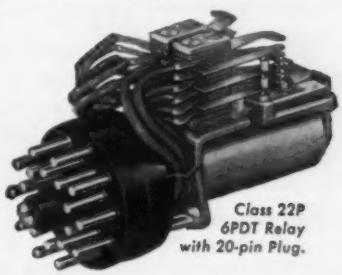
Special heavy duty contact arms and contacts switch 10 amperes (non-inductive) reliably in heavy duty service.

Contact combinations up to 4PDT for DC operation and DPDT for AC. Operating voltages to 230 V, DC and 440 V, 60 C.

Resistance to shock, vibration and temperature change to meet military specifications.

Heavy duty contacts can also be furnished in combinations with normal or low level signal load contacts.

Available with plug-in mounting, also dust tight or hermetically sealed enclosure.



Class 22P 6PDT Relay with 20-pin Plug.

Magnecraft Plug-in Relays

- Simplify wiring — may be plugged in after equipment is installed.
- Easily removed or replaced — no special skill or equipment required.
- Permit inspection, testing or adjustment with negligible down time.

Available for wide range of requirements.

Tell us what you need or send for catalog.

MAGNECRAFT
Electric Company
3350B W. Grand, Chicago 51, Ill.

CIRCLE 121 READERS SERVICE CARD

the specs are the proof . . .
the BEST BUYS are EICO
for COLOR & Monochrome TV servicing

NEW COLOR and Monochrome DC to 5 MC LAB & TV 5" OSCILLOSCOPE

=460 Factory-wired and tested $129.50
Also available as kit $79.95

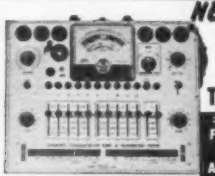
• **Features DC Amplifiers!**

Flat from DC-4.5 mc, usable to 10 mc. **VERT. AMPL.:** sens. 25 rms mv/in; input Z3 megs; direct-coupled & push-pull **thruout;** K-follower coupling bet. stages; 4-step freq-compensated attenuator up to 1000:1. **SWEEP:** perfectly linear 10 cps-100 kc (ext. cap. for range to 1 cps); **pre-set TV V & H positions** auto. sync. ampl. & lim. **PLUS:** direct or cap. coupling; bal. or unbal. inputs; edge-lit engraved lucite graph screens; dimmer; filter; bezel fits std. photo equipt. High intensity trace CRT. 0.06 usec rise time. Push pull hor. ampl., flat to 400 kc, sens. 0.6 rms mv/in. Built-in volt. calib. Z-axis mod. Sawtooth & 60 cps outputs. Astig. control. Retrace blanking. Phasing control.

NEW TV-FM SWEEP GENERATOR & MARKER

=368 Factory-wired and tested $119.95
Also available as kit $69.95

Entirely electronic sweep circuit (no mechanical devices) with accurately-biased **incrementor** for excellent linearity. **Extremely flat** RF output; **new AGC circuit** automatically adjusts osc. for max. output on each band with min. ampl. variations. **Exceptional tuning accuracy;** edge-lit hairlines eliminate parallax. **Swept Osc. Range** 3-216 mc in 5 **fund. bands. Variable Marker Range** 2-75 mc in 3 **fund. bands;** 60-225 mc. on harmonic band. **4.5 mc Xtal Marker Osc., xtal supplied.** Ext. Marker provision. Sweep Width 0-3 mc lowest max. deviation to 0-30 mc highest max. dev. 2-way blanking. Narrow range phasing. Attenuators: Marker Size, RF Fine, RF Coarse (4-step decade). Cables: output, scope horiz., scope vertical.



NEW DYNAMIC CONDUCTANCE Tube & Transistor Tester

=666 Factory-wired and tested $109.95
Also available as kit $69.95

COMPLETE with steel cover and handle.

SPEED, ease, unexcelled accuracy & thoroughness. **Tests all receiving tubes** (and picture tubes with adapter). **Composite indication** of Gm, Gp & peak emission. **Simultaneous sel** of any 1 of 4 combinations of 3 plate voltages, 3 screen voltages, 3 ranges of continuously variable grid voltage (with 5% accurate pot). **New series-string voltages:** for 600, 450, 300 ma types. **Sensitive** 200 ua meter. **5 ranges meter sensistivity** (1% shunts & 5% pot.) **10 SIX-position lever switches:** free point connection of each tube pin. **10 push-buttons rapid** insert of any tube element in leakage test circuit & speedy sel. of individual sections of multi-section tubes in merit tests. **Direct-reading** of inter-element leakage **in ohms. New gear-driven rollchart. Checks n-p-n & p-n-p transistors:** separate meter readings of **collector leakage current & Beta** using internal dc power supply. **CRA Adapter $4.50**

See the 50 EICO models IN STOCK at your neighborhood distributor. Write for FREE Catalog E-5

Prices 5% higher on West Coast

EICO® 33-00 NORTHERN BLVD LONG ISLAND CITY

CIRCLE 122 READERS SERVICE CARD

con, an instrument designed to operate either as a digital voltmeter or as an analog to digital converter. It is capable of 2,000 completely independent conversions per sec, and is completely transistorized to eliminate noise and heat and to reduce maintenance to a minimum. One of the new features of Voldicon is printed-circuit cards which are designed to prevent error. **Circle 349 on Reader Service Card.**

Ground Power System for aircraft

VARO MFG. CO., INC., 2201 Walnut St., Garland, Texas. Model 2615 is a 15 kva motor-clutch-generator set having 400 cps ± 0.1 percent frequency regulation. It is designed for automatic pre-launch checkout of missile systems. A unique control allows tracking of an external reference, automatic synchronization with and load transfer to the missile airborne supply. **Circle 350 on Reader Service Card.**

Silicon Rectifier nine cabinet styles

CHRISTIE ELECTRIC CORP., 3410 W. 67th St., Los Angeles 43, Calif., has developed a line of automatic-

reliability

At Hughes the Systems Engineering approach is considered essential for optimum reliability.

The basic design of complex electronic systems is relatively more advanced than the Reliability Engineering which will ensure their successful operation.

Thus, the challenge of the reliability barrier now requires the optimum application of creative engineering.

Several openings for both senior and junior engineers—preferably with radar systems, missiles, or communications backgrounds—now exist in these areas of reliability: Prediction, Design Review, Analysis, Promotion. Your inquiry is invited. Please write Mr. J. C. Bailey at the address below.

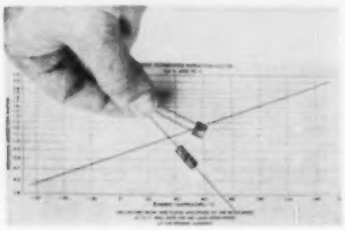
the West's leader in advanced electronics

HUGHES

Scientific and Engineering Staff
RESEARCH & DEVELOPMENT LABORATORIES
Culver City, California

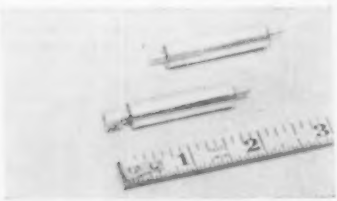
ally regulated silicon power rectifiers. Designed principally for missile testing and general use, the new line includes standard models from 30-1,500 amperes in nine different cabinet styles. Voltage ranges from 5½ to 135 v d-c.

Through a highly stable magnetic amplifier control (using only static components, the manufacturer claims precise regulation ± 0.5 percent, fast response 0.1 sec, and low ripple of 1 percent rms. **Circle 351 on Reader Service Card.**



Solid State Device two configurations

TEXAS INSTRUMENTS INC., P.O. Box 312, Dallas, Texas. The Sensistor silicon resistor has a 0.7 percent per deg C positive temperature coefficient of resistance. It is expected to have wide application as a temperature compensating device in miniaturized amplifiers, servos, computer switching circuits, magnetic amplifiers and power supplies. There are two configurations, both in standard resistance ratings ranging from 100 to 1,000 ohms at 25 C. **Circle 352 on Reader Service Card.**



Coax Components microminiaturized

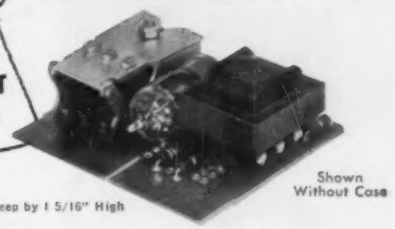
ELECTRO-PHYSICS LABORATORIES, 2065 Huntington Drive, San Marino, Calif., announces two new rugged microminiature coaxial com-

VECO Trade Mark

COMPACTROL

AN Ultra-Sensitive ELECTRONIC CONTROL

MINIATURIZED PRINTED CIRCUIT PLUG-IN TYPE



Shown Without Case

3" Wide, 2 13/16" Deep by 1 5/16" High

COMPACTROL is a thyratron amplifier with power relay, associated circuitry and 115 v a.c. power supply. It is self-contained and compactly packaged in a plastic case of high impact styrene.

INPUT — ⅛ microwatt to operate

OUTPUT — 1 to 3 poles, each 5 amps. at 250 volts a.c.

APPLICATIONS

- Super-sensitive relay
- Temperature control
- Automation
- Time delay relay
- Touch control
- Photo-electric device
- Intruder alarm
- Safety device
- Sales promotional display

WRITE FOR DESCRIPTIVE FOLDER V-318

Victory ENGINEERING CORPORATION

101 SPRINGFIELD ROAD UNION, N. J.

Telephone: MUrdock 8-7150

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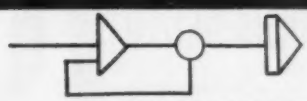
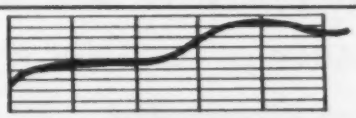
CIRCLE 124 READERS SERVICE CARD

for THAT NEW IDEA



IN ANALOG COMPUTING



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Electronic Associates, Inc.

Manufacturers of PACE Precision Analog Computing Equipment

LONG BRANCH, NEW JERSEY

TEL. CAPITOL 9-1100

Here's information you'll want on STANDARD precision timers

Accurate, reliable, versatile Elapsed Time Indicators. Synchronous motor drive, manual or electric zero reset. Electric clutch controlled by manual or automatic switch or output of electronic tubes. Units available for flush panel mounting or portable use.

Model	Scale Divisions	Totalizes	Accuracy
S-100	1/5 sec.	6000 sec.	±.1 sec.
S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
MST-500	1/1000 sec.	30 sec.	±.002 sec.

REQUEST BULLETIN NO. 198

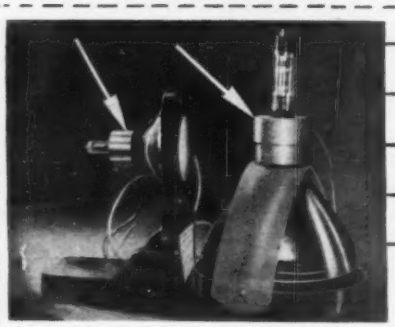
THE STANDARD ELECTRIC TIME COMPANY
89 LOGAN STREET • SPRINGFIELD, MASSACHUSETTS

CIRCLE 126 READERS SERVICE CARD

Celco TRANSISTORIZED YOKES

¾" ★ 1" ★ 1⅛" ★ 2" ★ 2½" CRT NECK DIA.

for MILITARY and COMMERCIAL PRECISION DISPLAYS



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–FAST RECOVERY
–HIGH SENSITIVITY
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–CONTROLLED MAGNETIC FIELDS

Write for CELCO DEFLECTION YOKE Catalogue & Design Sheets or for immediate engineering assistance Call your nearest CELCO Plant:

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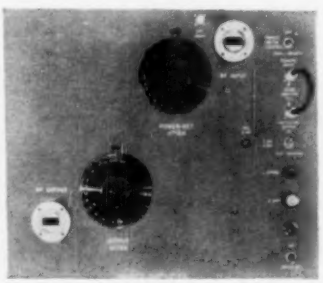
Celco Constantine Engineering Laboratories Co.

ponents—attenuators with a precision of ±0.5 db, and impedance matching pads having a low loss. Dimensions of both are ⅜ in. diameter by 2 in. length. These units are designed for ½ w input power, and mate with EPL microminiature coaxial connectors. Both components are carried in stock for most impedance ratios and values. **Circle 353 on Reader Service Card.**



Power Amplifier for X-band use

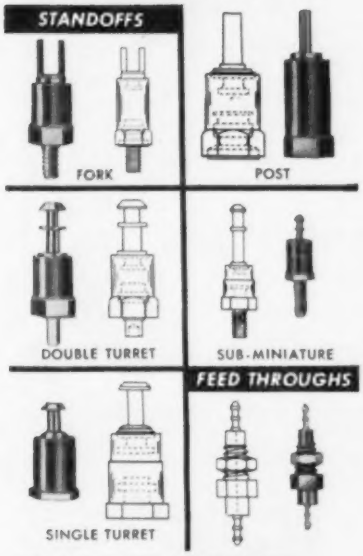
RESDEL ENGINEERING CORP., 330 So. Fair Oaks Ave., Pasadena, Calif. No. 90173 X-band pulse/c-w power amplifier consists of a wide-band twt, power supply, and air cooling assemblies requiring a total of approximately 38 in. of 19-in. relay rack space.

Specified minimum output is 4 w, 8,000-10,000 mc, but up to 14 w is commonly obtained at the upper end of the range. Hum and noise are 30 db below full output minimum. Leakage is −80 dbm maximum. **Circle 354 on Reader Service Card.**

D-V Storage Tube black background

ALLEN B. DUMONT LABORATORIES, INC., 750 Bloomfield Ave., Clifton, N. J. Images on radar screens, half-

GET THE EXACT TERMINAL YOU NEED *AT NEW LOW PRICES!*



FROM THE LARGEST STANDARD and CUSTOM LINE AVAILABLE...

Over 100 varieties are furnished as standard. This includes a full range of types, sizes, body materials and plating combinations. Specials can be supplied to any specification. The Whitso line is complete to the fullest extent of every industrial, military and commercial requirement.

Standoff terminals include fork, single and double turret, post, standard, miniature and sub-miniature body types—male, female or rivet mountings—molded or metal base. Feed through terminals are furnished standard or to specification.

Whitso terminals are molded from melamine thermosetting materials to provide optimum electrical properties.

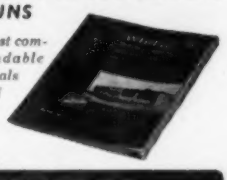
Body Materials: Standard as follows—melamine, electrical grade (Mil-P-14, Type MME); melamine impact grade (Mil-P-14, Type MMI); and phenolic, electrical grade (Mil-P-14, Type MFE).

Plating Combinations: Twelve terminal and mounting combinations, depending on electrical conditions, furnished as standard.

Specials: Body materials and plating combinations, also dimensions, can be supplied to any custom specifications.

PROMPT DELIVERY IN ECONOMICAL QUANTITY RUNS

Get facts on the most complete, most dependable source for terminals and custom molded parts. Request catalog.



WHITSO, INC.

9328 Byron Street, Schiller Park, Illinois
(Chicago Suburb)

CIRCLE 128 READERS SERVICE CARD

tone or black and white, can now be retained for more than five minutes and viewed in virtually any ambient light environment, by use of the black background direct-view storage tube. Applications are for fire-control radar; airplane-cockpit radar display; airport surveillance; transient studies; and visual communications. Circle 355 on Reader Service Card.

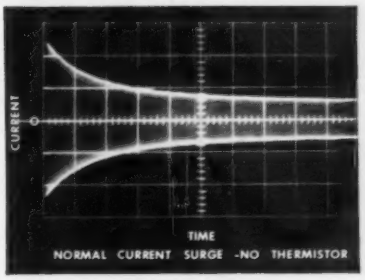
Video Transformers tiny, wideband

ESC Corp., 534 Bergen Blvd., Palisades Park, N. J., announces a new line of wideband video transformers. These subminiature units with wide bandwidth (50 cps to 8.0 mc) are used to replace bulkier components, for creating greater economy and increasing equipment efficiency. Transformers are supplied with solder terminals. They meet all applicable Mil-Specs. Circle 356 on Reader Service Card.

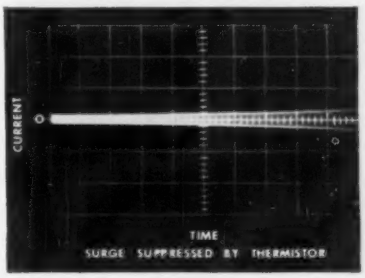
Panel Meter miniaturized

International Instruments Inc., P.O. Box 2954, New Haven, Conn., announces a new 1½-in. 300 deg scale panel meter. Model 173 has a 3.4-in. scale length, which is comparable to that of 4½-in. meters

THERMISTORS



SUPPRESS INITIAL SURGE CURRENTS...



PROTECT FILAMENTS

Application of voltage to tubes in receivers, transmitters, computers, and other electronic equipment subjects their filaments to initial current surges (top oscillogram).

These surges cause premature failure or unsatisfactory service life. Bottom oscillogram shows how a G-E thermistor can suppress the surge and protect the tube filaments.

The thermistor has a large *negative* temperature coefficient of resistance. The high resistance holds surge current to a low value during initial application of voltage. As the cold filament gradually heats up – raising its resistance to normal level – the thermistor's resistance lowers to a negligible value, permitting full current to flow after a brief period.

G-E thermistors can also be used to prevent surges from operating relays, or disturbing sensitive apparatus. They can provide time delay, control warning circuits, sequence switching.

For more information, or thermistor test kits, write: *Magnetic Materials Section, General Electric Company, 7806 N. Neff Blvd., Edmore, Michigan.*

THERMISTOR TEST KITS
$12.50 each

Kit A: 12 DISKS (10-000 OHMS), 6 SIZES.
Kit B: 12 DISKS (100-100,000 OHMS), 6 SIZES, 2 GRADES.
Kit C: 12 WASHERS AND RODS (10-015 OHMS), 6 SIZES, 2 GRADES.
Kit D: 10 DISKS (100 OHMS), 5 SIZES, 2 GRADES.

Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 129 READERS SERVICE CARD

Krohn-Hite
VARIABLE ELECTRONIC FILTERS

MODELS 330-A and 330-M

FEATURING

- ULTRA-LOW FREQUENCY COVERAGE
- 100,000 to 1 FREQUENCY RANGE IN ONE INSTRUMENT
- DIRECT FREQUENCY CALIBRATION

The Krohn-Hite Filter Line

Model	Type	Frequency Range	Price
310-AB*	Band Pass	20 cps to 200 kc	$295.00
330-A*	Band Pass	.02 cps to 2 kc	$475.00
330-M*	Band Pass	0.2 cps to 20 kc	$475.00
340-A	Servo	.01 cps to 100 cps	$385.00
350-A*	Rejection	.02 cps to 2 kc	$475.00
360-A*	Rejection	20 cps to 200 kc	$295.00

*Available for rack mounting at $5.00 additional.

For further information on:

- Filters
- Power Supplies
- Oscillators
- Power Amplifiers

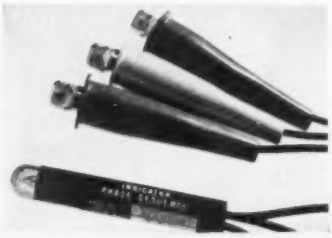
write for our free catalog D

Krohn-Hite CORPORATION
580 MASSACHUSETTS AVENUE
CAMBRIDGE 39, MASS., U. S. A.

CIRCLE 130 READERS SERVICE CARD

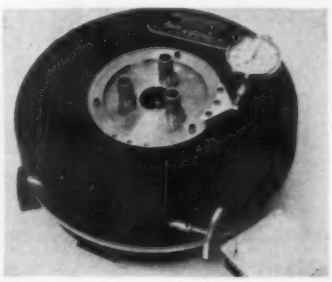
of conventional type. Accuracy is held to ± 3 percent of full scale deflection, and it is expected that this meter will find wide application in portable, airborne and other equipment where weight or panel space must be saved.

The meters, featuring a miniaturized D'Arsonval movement, are self-contained, individually calibrated for use on magnetic or nonmagnetic panels, and supplied ready for use. **Circle 357 on Reader Service Card.**



Indicator
phase sequence

MASTER SPECIALTIES CO., 956 E. 108th St., Los Angeles 59, Calif., announces a 6-oz pocket-size phase sequence indicator. It detects and signals correct phase sequence of three phase power supplies. No moving parts are used. A resistance-capacitance phase sequence sensing network drives a neon indicator lamp. The neon lamp will illuminate only if phase sequence is correct, and all leads energized. **Circle 358 on Reader Service Card.**

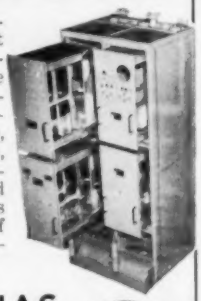


Angular Divider
for synchros and pots

THETA INSTRUMENT CORP., 48 Pine St., E. Paterson, N. J. Shaft

CABINETS

Precision construction to exact specifications! Complete packaged aluminum cabinets — basic structure, side panels, doors, front panels, interior chassis and frame structures for support of electronic equipment.



ANTENNAS

Circular and rectangular parabolic antennas with reflector tolerances to meet the most rigid specifications . . . fabricated to order.

CONSULT OUR ENGINEERING STAFF in pre-designing or development stages of any project at No Obligation.

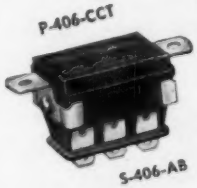
WACO T.M. Reg. Canada

WASHINGTON ALUMINUM CO. INC.
Dept. 255 Baltimore 29 Md. Circle 2-1000

CIRCLE 131 READERS SERVICE CARD

FOR PUBLIC ADDRESS, RADIO, and kindred fields, JONES 400 SERIES PLUGS & SOCKETS
of proven quality!

P-406-CCT



S-406-AB

Socket contacts phosphor bronze cadmium plated. Plug contacts hard brass cadmium plated. Insulation molded bakelite. Plugs and sockets polarized. 2, 4, 6, 8, 10, 12 contacts Steel caps with baked black crackle enamel.

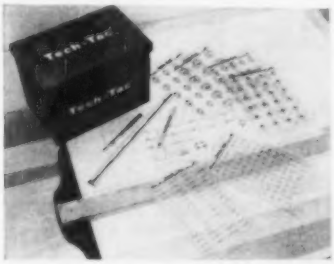
Catalog No. 21 gives full information on complete line of Jones Electrical Connecting Devices — Plugs, Sockets and Terminal strips. Write

Jones HOWARD B. JONES DIVISION
CINCH MANUFACTURING CORPORATION
CHICAGO 24, ILLINOIS
SUBSIDIARY OF UNITED-CARR FASTENER CORP.

CIRCLE 132 READERS SERVICE CARD

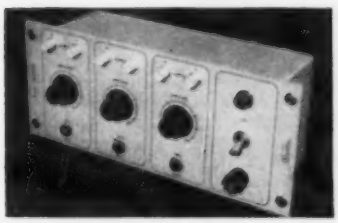
of rotating components are positioned to an accuracy of 20 sec of arc, and flexible couplings are avoided by a new technique of using the synchro shaft to locate the center of rotation of the synchro housing in the model D-3 precision angular divider.

Unskilled operators can handle this mechanism since collecting is automatic and readings are direct. Adaptation to all housing and shaft sizes can be accomplished in approximately one minute at a cost of $100 per adapter. **Circle 359 on Reader Service Card.**



Electronic Symbols pressure applied

TECH-TAC, INC., 727 W. Seventh St., Los Angeles 17, Calif. Pressure applied electronic symbols on clear acetate as a drafting aid are available. All standard symbols to fit JAN, MIL, ASA requirements are included. Complete system consists of 165 numbered paper backed acetate sheets on each of which are an average of 48 symbols, depending on size. **Circle 360 on Reader Service Card.**



Pulse Generator high powered

NAVIGATION COMPUTER CORP., 1621 Snyder Ave., Philadelphia 45, Pa. Model 1015A power pulse gen-

ESTERLINE-ANGUS

"The Meter With a Record" for Over 50 Years

CAN CUT COSTS FOR YOU NOW

$$\frac{100}{\%\ \text{Profit}} \times \$\ \text{Savings} = \$\ \text{Sales}$$

Reducing costs, eliminating waste, saving power—Any Reduction in Operation Cost—contributes directly to profit. *In many plants, a cost reduction of $100 a month has the same effect on profit as sales of $20,000 a year.*

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Electroplated WIRES *for many applications*

Continuous electroplating methods permit coating of many metals on to wire (or ribbon) in specified thicknesses of plate . . . This very flexible operation makes it possible to designate a desirable base or precious metal with a coating of another metal for its own particular characteristics. In our laboratory Tungsten wire as small as .00015" has been electroplated with Gold. . . . New combinations of plating on wire are being developed by our research staff from time to time.

SINCE 1901

Consult us, without obligation, about your specific wire problems. Write for list of products.

SIGMUND COHN MFG. CO., INC.
121 SOUTH COLUMBUS AVENUE · MOUNT VERNON NEW YORK

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ARNOLD / TOROIDAL COIL WINDER

sets up quickly... easy to operate... takes wide range of wire sizes

SPECIFICATIONS:

- Min. finished hole size: .18 in.
- Max. finished toroid O.D.: 4.0 in.
- Winding speed: 1500 turns/min.
- Wire range: AWG 44 to AWG 26
- Dual, self-checking turns counting system
- Loading (wire length) counter
- Core range: ¼" I.D. to 4" O.D. to 1½" high

LABORATORY USE

- Change wire *and* core size in 45 sec.

PRODUCTION USE

- 1500 turns per minute
- Insert core and load in 20 sec.

includes all rings, counters and accessories

We also wind toroidal transformers for military environment to your specifications.

IMMEDIATE DELIVERY. *Literature on request*

ARNOLD MAGNETICS CORP.

4615 W. Jefferson Blvd., Los Angeles 16, Calif.
REpublic 1-6344

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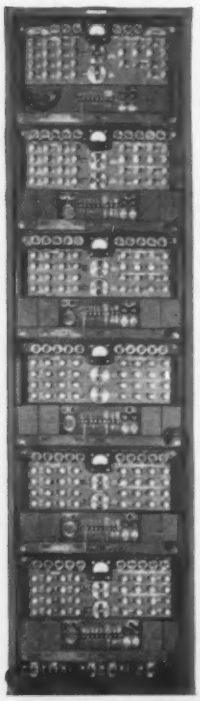

MINIATURIZED CARRIER TELEPHONE SYSTEMS FOR RADIO AND 4-WIRE CABLE

FOUR OR 24 CHANNELS

Two miniaturized voice-multiplex systems providing four or 24 voice channels over radio or 4-wire cable are available. They have many advantages over earlier designs: high performance, small size, light weight, low cost, circuit simplicity, low power requirements, small number of tubes of a single type only, low operating cost, low maintenance and high reliability.

These systems provide a voice-channel flat within 1 db from 300 to 3500 cycles, for each 4 kc of bandwidth occupied. Each channel is equipped with hybrid, signalling, and dialling circuits for all the standard 2-wire and 4-wire loop options.

The basic unit provides an order-wire and 4 carrier-derived channels. These units can be stacked in groups of 2, 3, 4 or 5 by means of a group modem to provide 9, 14, 19 or 24 channels. Full flexibility is provided for dropping and inserting channel groups at repeater and terminal points. Moderate lengths of 4-wire cable or open-wire line may be inserted between the multiplex equipment and the radio terminals.

24-channel carrier-telephone terminal complete with hybrids, ringing and dialling circuits, and test facilities. Dimensions are 58" high, 16" wide and 8" deep. Power input 250 watts. Weight 326 lbs.

RADIO ENGINEERING PRODUCTS
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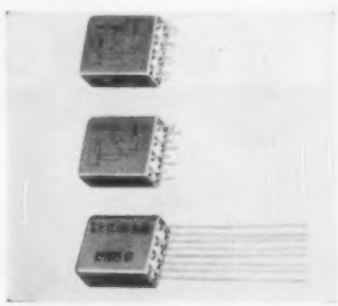
TELEPHONE
UNiversity 6-6887
CABLES
RADENPRO, MONTREAL

erator contains three independent sections which produce 0.1 μsec pulses of 30 v amplitude, when triggered by external voltage transients. Output amplitude is variable from 0 to 30 v, and in both positive and negative polarities. Input is a-c coupled and may be triggered by any negative transient of at least 1 μsec per 1 v. **Circle 361 on Reader Service Card.**

Pulse Counter linear amplifier

TECHNICAL MEASUREMENT CORP., 140 State St., New Haven, Conn., has developed the model PA-3B differential integral pulse height selector with linear amplifier. The analyzer section features three modes of operation: an integral mode for counting all pulses above the base line; a 0-10 v window mode; and an upper limit mode which makes the window control a 0 to 100 v upper limit, for counting pulses between lower and upper limits. Amplifier section has binary gains controls from 1 to 64; maximum gain is 8,000; RC clipping is fixed. **Circle 362 on Reader Service Card.**



Sealed Relay ultrasmall, light

C. P. CLARE & Co., 4101 Pratt Blvd., Chicago 45, Ill. Type F hermetically sealed relay—no bigger

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The Johns Hopkins University

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BETHESDA 14, MARYLAND

than a postage stamp—is designed to fill the demand for a smaller, lighter relay stalwart enough to withstand extremes of temperature, heavy shock and extreme vibration, yet fast and more than moderately sensitive.

Type F is rated for ambient temperatures from −65 C to +125 C. It is tested for shock of 50 g for 11 millisec. Vibration tests show from 5-75 cps at maximum excursion of ¼ in. (75-2,000 cps at 20 g acceleration). Pickup time is 3.5 millisec nominal; drop-out time, 1.5 millisec nominal. **Circle 363 on Reader Service Card.**

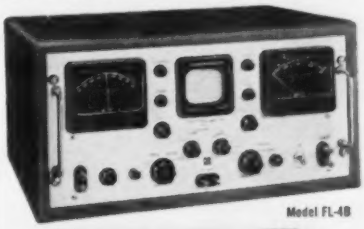
Electrocardiograph transistorized

SANBORN CO., 175 Wyman St., Waltham 54, Mass. The direct-writing model 300 Visette ECG electrocardiograph is the size of a small overnight case and weighs only 18 lb complete. Three vacuum tubes and a dozen transistors and diodes are used in the circuit, which records fractional-millivolt action potentials of the heart as a permanent tracing on a strip chart, by means of a recording galvanometer. All amplifier circuitry is contained on plug-in printed wiring panels, to facilitate any servicing that may be necessary. **Circle 364 on Reader Service Card.**

SYNONYMOUS

d&r LTD. FLUTTER METERS

For the most complete line of Flutter Meters, there is only one source — d & r LTD. From the meters used in simple maintenance test equipment to the most complex standardization and analysis equipment for missile flight systems and telemetering systems – we make them all.



Model FL-4B

WIDEBAND FLUTTER METERS

MODEL FL-3D FLUTTER AND WOW METER

Features
A convenient instrument of moderate cost for use in field maintenance of music-system tape recorders and reproducers, and phonograph turntables.

Specifications
Carrier frequency – 3000 cps, stabilized oscillator
Bandwidth – within 3 db to 250 cps modulation
Bandwidth Selection – 0.5 to 6 cps, 6 to 250 cps, 0.5 to 250 cps
Scale Ranges – 2% and 0.5% full scale rms

Price: $225.00

MODEL FL-4B WIDEBAND FLUTTER METER

Features
A very sensitive broadband instrument for laboratory use in the precise measurement of small amounts of flutter with components up to 5000 cps. Most frequently used in telemetering and data reduction systems.

Specifications
Carrier Frequncy – 14,500 cps, crystal controlled
Bandwidth – D-c to 5000 cps within 6 db
Bandwidth Selection – Full range above, 0.5 to 30 cps, 30 to 300 cps, 300 to 5000 cps.
Scale Ranges – 0.2%, 0.6% and 2.0% rms full scale
Drift Meter – ±2.0% frequency change d.c. to 4 cps
Display – 3-inch flat-face oscilloscope for flutter analysis

Price: $965.00 rack mounted, $1000.00 in cabinet

MODEL FL-5A LABORATORY STANDARD FLUTTER METER

Features
An extremely stable (temperature controlled discriminator) instrument with great sensitivity and extended bandwidth for laboratory work in connection with precision instrumentation data recorders. Galvanometer outputs provided.

Specifications
Carrier Frequencies – 40 kc. and 70 kc., crystal controlled
Bandwidth – D.c. to 10 kc. with 70-kc. carrier to 4 kc. with 40 kc. carrier
Indicating Instruments – Level Meter, and ±2% Drift Meter
Output Signals – Scope, two galvanometer outputs
Sensitivity – 0.05%, 0.2% and 2.0% selectable
Drift – On d-c galvo. output, less than 10 parts per million in ½ hour

Price: $3450.00 rack mounted

MODEL FL-6A BROADCAST FLUTTER METER

Features
An instrument designed for accurate measurement and analysis of flutter and wow in high-quality audio tape recorders.

Specifications
Carrier Frequency – 8000 cps., stabilized oscillator
Bandwidth – D.c. to 1200 cps.
Bandwidth Selection – Full range, 0.5 to 30, 30 to 300, 300 to 1200 cps.
Scale Ranges – 0.2%, 0.6%, and 2.0% rms full scale
Display – 3-inch oscilloscope for waveform observation

Price: $845.00 rack mounted, $880.00 in cabinet

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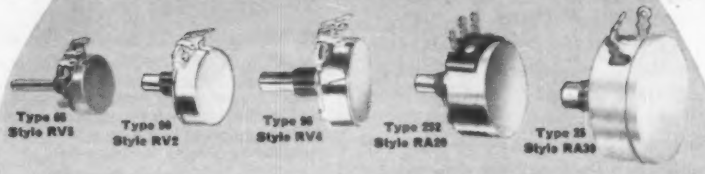

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Literature of

MATERIALS

Alumina Ceramic. Coors Porcelain Co., Golden, Colorado. Bulletin No. 358 is a 4-page folder covering AD-99 alumina ceramic, a dense, nonporous, 99 percent aluminum oxide ceramic. The material described features high strength at high temperatures, and ultra low dielectric loss characteristics at microwave frequencies. **Circle 250 on Reader Service Card.**

COMPONENTS

Electrical Connectors. Component Mfg. Service, Inc., Component Park, West Bridgewater, Mass. A 4-page illustrated folder discusses the company's custom service for producing electrical connectors of Molded-On one-piece construction. With the technique mentioned, wire ends and soldered joints are embedded and isolated from each other in a solid body of high impact insulating material. **Circle 251 on Reader Service Card.**

Miniature Chopper. The Bristol Co., Waterbury 20, Conn. A single-page bulletin illustrates and describes a new syncroverter dpdt miniature chopper designed for high reliability and long life in dry circuit applications. Characteristics and dimensional drawing are given. **Circle 252 on Reader Service Card.**

Reflex Klystrons. Eitel-McCullough, Inc., San Bruno, Calif., has available an illustrated booklet which covers the adaptation of ceramics to a new line of Eimac reflex klystrons. Specifications are included. **Circle 253 on Reader Service Card.**

Relays. Iron Fireman Mfg. Co., 2838 S. E. 9th Ave., Portland 2, Ore. A new catalog describes miniature and subminiature relays manufactured by the company. A special section includes data and charts for computing the character-

the Week

istics of relays under varying conditions of resistance, current, voltage, power and temperature. **Circle 254 on Reader Service Card.**

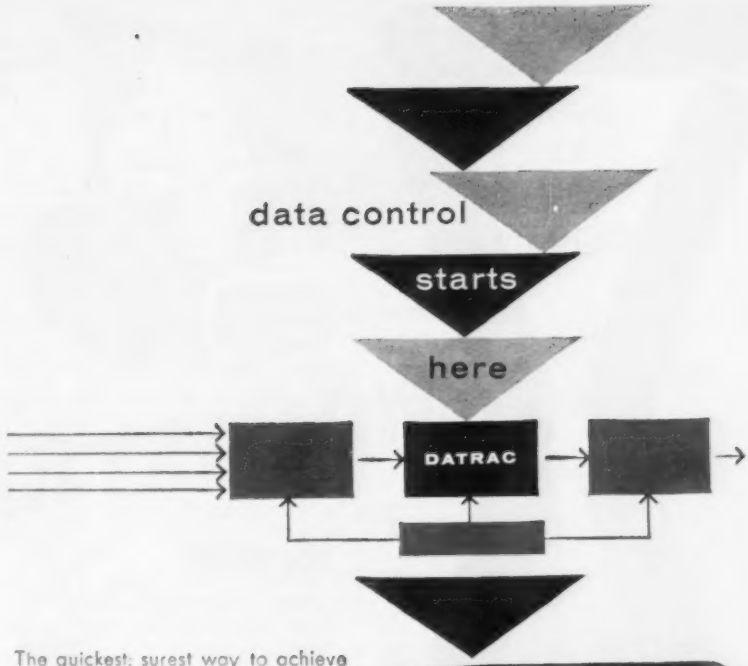
Silicon Rectifiers. Audio Devices, Inc., Rectifier Division, 620 E. Dyer Road, Santa Ana, Calif., has published a 64-page silicon rectifier handbook which explains the technicalities of these devices, how they are made, where they are used, and how to use them in many applications. Price is $1. **Circle 255 on Reader Service Card.**

Solderless Terminals. AMP Inc., Harrisburg 30, Pa. The Selectalog is a 20-page, four-color booklet summarizing the information contained in AMP's catalog series. Intended as a reference index for those concerned with modern electric circuitry, the brochure also constitutes a digest of solderless termination techniques. By using it, the engineer can select the catalog which offers the information he seeks. **Circle 256 on Reader Service Card.**

Tantalum Capacitors. Pyramid Electric Co., 1445 Hudson Blvd., North Bergen, N. J. A 4-page bulletin contains engineering data and electrical characteristics for a new slug-type tantalum capacitor line. **Circle 257 on Reader Service Card.**

Teflon Terminals. Sealectro Corp., 610 Fayette Ave., Mamaroneck, N. Y. A condensed listing of the most popular Press-Fit types—stand-offs, feed-throughs, connectors, test jacks, probes, plugs and taper-pin receptacles—is presented in a new catalog. **Circle 258 on Reader Service Card.**

Thermistor Probe Assemblies. Fenwal Electronics, Inc., Mellen St., Framingham, Mass. Nine specially designed thermistor probe assemblies are described in detail in a new 4-page brochure. Each assembly is identified by its most common application, and has com-



The quickest, surest way to achieve true data control in digital systems is to specify an Epsco Model B DATRAC voltage-digital converter.

RELIABLE — Epsco pioneered the field of high-speed data conversion techniques . . . is today considered its leader. Epsco DATRACS have been field-proven in hundreds of installations, coast-to-coast.

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Epsco, Incorporated, 588 Commonwealth Ave., Boston 15, Mass. *For service in the West: Epsco Service Corp. of California, 1722 Westwood Blvd., Los Angeles 24, California*

plete dimensions and mounting arrangements. **Circle 259 on Reader Service Card.**

Transistor Physics. Texas Instruments Inc., P.O. Box 312, Dallas, Texas. An 8-page reprint of an illustrated article entitled "Transistor Physics" is available. It contains information on the element germanium, discusses diode action and the diode equation. The author then introduces the concept of transistor action developing the necessary associated equations. **Circle 260 on Reader Service Card.**

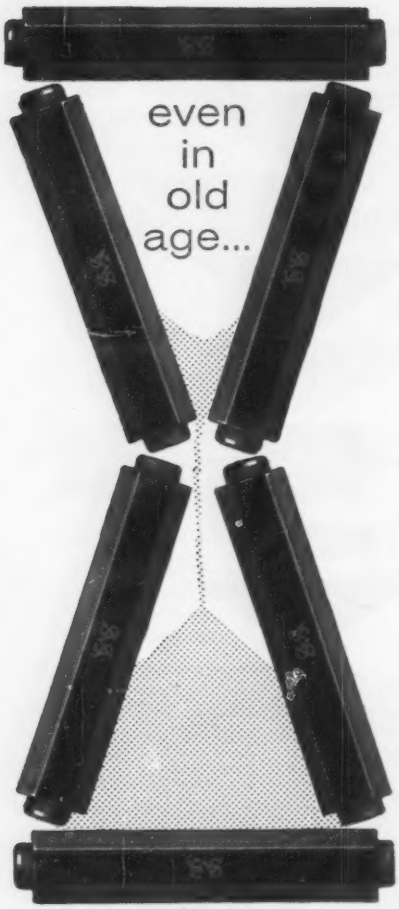
EQUIPMENT

Analog Computer. Donner Scientific Co., Concord, Calif. Eight-page data file 310 describes the model 3100 high accuracy, medium size analog computer. In design, analysis, or control problems, the computer discussed affords an accurate, time-saving model of an arbitrary physical system. **Circle 261 on Reader Service Card.**

Cable Supporting Systems. T. J. Cope Division, Rome Cable Corp., Collegeville, Pa. A new 60-page loose-leaf catalog contains the latest information on the company's complete line of cable supporting systems, including cable trough, cable ladder, cable channel, and Rak-it system supports and accessories. **Circle 262 on Reader Service Card.**

Electrical Control Equipment. Zenith Electric Co., 152 W. Walton St., Chicago 10, Ill. A 64-page brochure gives detailed information, technical data and prices on all types of automatic electrical control equipment. Applications, construction details, engineering information and operating features are included, as well as general data and design specifications. It is indexed in four sections—automatic transfer switches, contactors, special controls and timing devices. Request copies on company letterhead.

Instruments Data. Acton Laboratories, Inc., 533 Main St., Acton,



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S. S. WHITE resistors serve dependably in hundreds of commercial . . . industrial . . . and scientific applications. They are characterized by low noise level . . . precision . . . stability . . . negative temperature and voltage coefficients. Non-hydroscopic base withstands temperature and humidity. They are compact, have excellent stability and mechanical strength.

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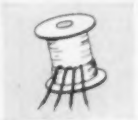

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Also, Transformers Made To Order

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Send for Bulletin E-58

HARPER-LEADER, INC.
Waterbury 20, Conn.
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Mass. A file type brochure provides condensed catalog data on a complete line of instruments. These include phase meters, phase standards, impedance meters, vtvm's, amplifiers, oscillographic recorders, potentiometer test equipment, knobs, dials and dual speed drives. **Circle 263 on Reader Service Card.**

Microwave Frequency Meter. Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N.Y. A single-sheet bulletin contains features and specifications of the type 587-A microwave frequency meter which has an extended range of 250 to 1,000 mc. Price of the unit described is $250. **Circle 264 on Reader Service Card.**

Portable P-A System. Polytronics Inc., 7326 Westmore Rd., Rockville, Md. A four-page folder illustrates and describes the Porta-Vox, a new portable self-powered p-a system. Applications and prices are included. **Circle 265 on Reader Service Card.**

FACILITIES

Printed Circuitry. Printed Electronics Corp., North St., Natick, Mass. A new brochure on printed circuitry, in file folder style, contains full descriptive data on materials, specifications, design tolerances, and application information. The patented Narcus Process for plating holes is described. PEC provides complete engineering services and manufacturing facilities for printed circuitry. **Circle 266 on Reader Service Card.**

Pulverizing Service. Liquid Nitrogen Processing Corp., 451 Booth St., Chester, Pa., has available literature announcing its service of pulverizing heat-sensitive materials with liquid nitrogen. The service discussed is indicated where (1) the materials might thermally degrade during pulverizing; (2) a reactive compound would be converted because of heat elevation; and (3) where the materials will soften or melt at a low temperature. **Circle 267 on Reader Service Card.**

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C 11 | 6.3 | 173 | .36"
C 2 | 6.3 | 171 | .44"
C 22 | 5.5 | 184 | .44"
C 3 | 5.4 | 197 | .64"
C 33 | 4.8 | 220 | .64"
C 4 | 4.6 | 229 | 1.03"
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TINY!
1 x 2 inch cross section
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Temperature: -54° C. to 85° C.
Vibration: 500 CPS, 10g
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Design and Manufacture of Electro-Mechanical Timing Devices

CIRCLE 146 READERS SERVICE CARD

Leach Opens New Facility

AN ELECTRIC CURRENT generated by the warmth of a human handshake literally turned on the power and put a new $1½ million manufacturing facility (picture) to work in Compton, Calif., recently.

Kenneth F. Julin, president of the Leach Corp., which produces controls and power for aircraft and missiles, held a small electric current producing device called a thermistor as he received a congratulatory open house handshake from Los Angeles Chamber of Commerce president George B. Gose.

Warmth of the handshake generated enough electricity in the thermistor to activate a system of sensitive Leach relays and set up a circuit which, amplified, turned on the new plant's lights and started its machinery.

The new Leach facility in suburban Compton contains 101,000 sq ft and houses corporate offices and two divisions—the Inet, which produces aircraft, missiles and control system equipment, and Special Products, which engages in new product development.

The original company, the Leach Relay, which claims to account for one-tenth of all relays produced in the U.S. for military and commercial airplanes, missiles and industrial purposes, is housed in a plant nearer the heart of Los Angeles.

Dedication of the new facility brought to a climax one third of a century of Leach history that began in San Francisco shortly after World War I with formation of a company making an automatic antenna switch and power relay. Founder was a former U.S. Navy radio operator, V. A. Leach.

Appoint Epstein Chief Engineer

CONTROL ELECTRONICS CO., INC., Huntington Station, N. Y., has appointed Markus M. Epstein (picture) as chief engineer.

Epstein, formerly with Empire Devices, Inc., also was associated at one time with the Fairchild Pilotless Plane Division and his background includes, as well, work with the Bell Aircraft Corp., Lewyt Corp., and the U. S. Army Signal Corps. His developments have covered the broad field from d-c devices through microwave systems and components. He has completed projects in radar, guided missiles controls, autopilots, microwave components and systems, noise and field intensity receivers, and precision power supplies.

Name Lehne V-P

APPOINTMENT of Henry Lehne (picture) as vice president of Sylvania Electronic Systems, a division of Sylvania Electric Products Inc., is announced. He continues as general manager of the division with headquarters in Waltham, Mass.

Lehne joined Sylvania in 1953 after serving for 14 years in various engineering and sales positions with Republic Aviation Corp.

Set Up New Firm In West

SIX executives (one marketing expert, five engineers) left a leading L. A. engineering firm at the end of January to organize their own development and manufacturing company, PARABAM, in El Segundo, Calif. Headed by Thomas A. Feeney, president, they expect their experience, ranging from 13 to 20 years apiece and their proven ability for teamwork to carry them through the current slump and up into the predicted third quarter defense spending upsurge. Applying stock speculation principles PARABAM decided to plunge in while the market is low.

Using their combined backgrounds in aircraft design, aircraft

new constant delay filters

give minimum intelligence distortion and maximum phase linearity in radar, telemetering and other missile applications

Now . . . Burnell & Co.'s new Type 60051 Constant Delay Filter series provide delay constant to within 5% over the Pass Band — solve troublesome distortion caused by non-linear systems.

It has become apparent that the phase characteristics of telemetering filters are of greater importance than amplitude characteristics in creating intelligence distortion and minimum transient response of frequency modulated signals.

Inasmuch as delay is constant where the derivative of the phase function is truly linear it is an important measure of phase linearity. To obtain constant delay, a complete circuit configuration revision based on a lattice structure is required.

For compactness, a standard type 60051 housing is available. Upon special order JHU-APL housings for circuit replacements can be supplied.

For more detailed information on constant delay filters write for Bulletin CD-051.

BAND PASS FILTERS

Channel	Frequency	Part #	Delay in ms.	B/W
1	.4 KC	S-60051	34.00	15%
2	.56 KC	S-60052	24.30	15%
3	.73 KC	S-60053	18.60	15%
4	.96 KC	S-60054	14.20	15%
5	1.3 KC	S-60055	10.50	15%
6	1.7 KC	S-60056	8.00	15%
7	2.3 KC	S-60057	5.93	15%
8	3.0 KC	S-60058	4.40	15%
9	3.9 KC	S-60059	3.38	15%
10	5.4 KC	S-60060	2.44	15%
11	7.35 KC	S-60061	1.80	15%
12	10.5 KC	S-60062	1.26	15%
13	14.5 KC	S-60063	0.91	15%
14	22. KC	S-60064	0.60	15%
15	30. KC	S-60065	0.44	15%
16	40. KC	S-60066	0.33	15%
17	52.5 KC	S-60067	0.252	15%
18	70. KC	S-60068	0.189	15%
A	22. KC	S-60069	.305	30%
B	30. KC	S-60070	.224	30%
C	40. KC	S-60071	.168	30%
D	52.5 KC	S-60072	.128	30%
E	70. KC	S-60073	.096	30%

CASE SIZE—4⅛ x 2 x 3½" H (CS-60051)
INPUT IMPEDANCE = 500 ohms
OUTPUT IMPEDANCE = 500 ohms and to grid

LOW PASS FILTERS

Frequency	Part #	Delay in ms
400 cps.	S-60101	2.95 ms
560 cps.	S-60102	2.11 ms
730 cps.	S-60103	1.62 ms
960 cps.	S-60104	1.23 ms
1300 cps.	S-60105	905 ms
1700 cps.	S-60106	681 ms
2300 cps.	S-60107	511 ms
3 KC	S-60108	392 ms
3.9 KC	S-60109	302 ms
5.4 KC	S-60110	218 ms
7.35 KC	S-60111	160 ms
10.5 KC	S-60112	112 ms
14.5 KC	S-60113	.0812 ms
22 KC	S-60114	.0535 ms
30 KC	S-60115	.0392 ms
40 KC	S-60116	.0294 ms
52.5 KC	S-60117	.0224 ms
70 KC	S-60118	.0168 ms
22 KC	S-60119	.0738 ms
30 KC	S-60120	.0541 ms
40 KC	S-60121	.0412 ms
52.5 KC	S-60122	.0309 ms
70 KC	S-60123	.0233 ms

CASE SIZE—1¹¹⁄₁₆ x 1⅞ x 2⅛" H
INPUT IMPEDANCE equals 500/600 ohms
OUTPUT IMPEDANCE equals 500/600 ohms

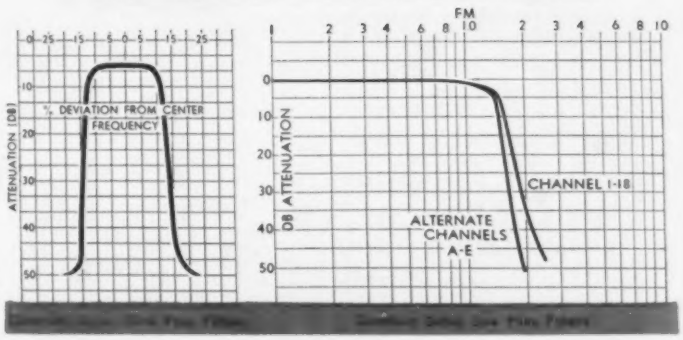
*optional impedance available on special order.

CONSTANT DELAY BAND PASS AND LOW PASS FILTERS ARE AVAILABLE WITH ATTENUATION SLOPES ILLUSTRATED

TECHNICAL DATA FOR BAND PASS FILTERS

FOR ± 7½% PASS BAND
1. Flat within 3 db over pass band
2. 21 db at ± 15% of center freq.
3. 40 db at ± 22% of center freq.
4. Time delay over the pass band, constant to ± 5%

FOR ± 15% PASS BAND
1. Flat to 3 db over pass band
2. Flat to 23 db at ± 30% of center freq.
3. Flat to 40 db at ± 44% of center freq.
4. Time delay over pass band constant to ± 7%



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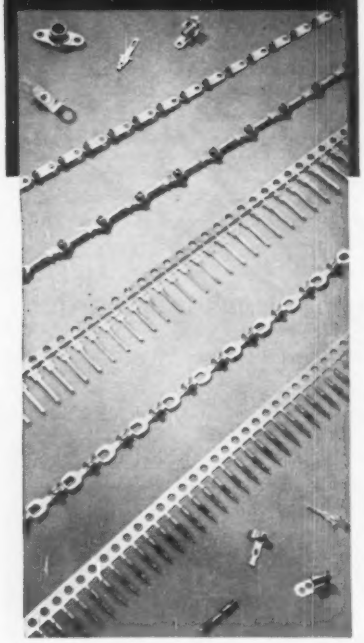

Tell us about your application and production requirements. We'll supply your needs from our complete line—or adapt to your specifications—and show you how to cut costs and speed up production!

- **Miniature Tubular Terminals, Wire Wrap Terminals and Contacts for Automated Printed Circuit Applications**
- **Solderless Crimp-on Terminals**
- **Line Cord Interlock Terminals**
- **Automatic terminal inserting, crimping and staking machines**

Contact us today. Send blue print or specifications for specific information. Request bulletins for general information.

Malco TOOL and MANUFACTURING CO.

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systems and components, range instrumentation, and data handling systems, etc. PARABAM's principals will produce such items in their 2,000 sq ft facilities subrented from Consolidated Aircraft Products Co., next door. By written agreement PARABAM has available the production facilities and capabilities of Consolidated on a specific job basis. PARABAM has its own labs and room for 25 employees; does its own wiring and final assembly.

Philco Promotes Hockeimer

NEW MANAGER of the field engineering department of Philco Corporation's Government and Industrial Division is Henry E. Hockeimer (picture). He has been with Philco since 1947 and has served in various field and headquarters assignments. He joined the G and I Division in 1951 as a project engineer on Philco's early microwave installations and has been assistant manager of field engineering since 1955.

Corning Glass To Expand

CORNING Glass Works, Corning, N. Y., will build a new plant at Bradford, Pa., for the manufacture of electronic components. The one-story factory will have 142,560 sq ft of floor space. It will employ approximately 450 people, all of

MEGACYCLE METER

0.1 Mc to 940.0 Mc

Model 59-LF Oscillator 100 Kc—4.5 Mc

Model 59 Oscillator 2.2 Mc—420 Mc

Model 59—UHF Oscillator 420 Mc—940 Mc

Write for Bulletin

Determines resonant frequency of tuned circuits, antennas, transmission lines, by-pass condensers, chokes, etc. Measures inductance and capacitance. Also used as a signal generator, wave meter, frequency meter, and in many other applications.

This compact, lightweight grid-dip meter is available in the frequency ranges indicated.

Laboratory Standards

MEASUREMENTS

A McGraw-Edison Division

BOONTON, NEW JERSEY

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Men on the Move

Now available in a *new edition* . . . with *new figures.*

This popular booklet points up the important sales problem of personnel turnover in industry. Out of every 1,000 key men (over a 12-month period) 343 new faces appear . . . 65 change titles . . . 157 shift . . . and 435 stay put. These figures are based on average mailing address changes on a list of over a million paid subscribers to McGraw-Hill magazines.

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Company Promotion Department

McGraw-Hill Publishing Co., Inc.

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whom will be transferred from facilities now leased in Bradford.

Ground was broken recently and the plant is scheduled to be in operation by the end of the year. This will be the tenth new manufacturing unit to have been constructed by the company in the past ten years.

Appoint Miller Chief Engineer

Ross F. Miller (picture) is named chief engineer of the electronic systems and equipment element of Nortronics, Hawthorne, Calif. The appointment follows the establishment of Nortronics as an operating division of Northrop Aircraft, Inc., and the formation of operating elements of the new organization.

Miller is known for his work in the field of military electronics. He played a prominent role in the development of a successful intercontinental guidance system for the Northrop SM-62 Snark missile.

Navy Honors Missile Men

For outstanding contributions to the national defense in the fields of scientific research and development and missile guidance technology, six men were recently honored by the U.S. Navy.

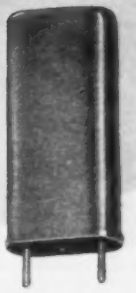
Recipient of the Distinguished Public Service Award, the Navy's highest civilian award, was Royden

NEW at Monitor!

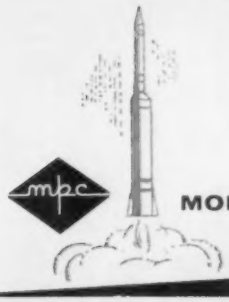
Low Frequency crystals to meet high vibration requirements

Fully tested from 2 to 2,000 CPS vibration. Acceleration of 15 to 30 G's. Frequency range 16 to 100 kc — typical tolerance ± .012% from −40°C to + 70°C. Lower frequencies down to 400 cycles available in other Monitor types with less rigid requirements.

Monitor's modern facilities and techniques insures the quality of all units.



Small size MC-13/U



If you have a special crystal problem, call, wire or write.
SEND FOR NEW CATALOG!

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CIRCLE 149 READERS SERVICE CARD

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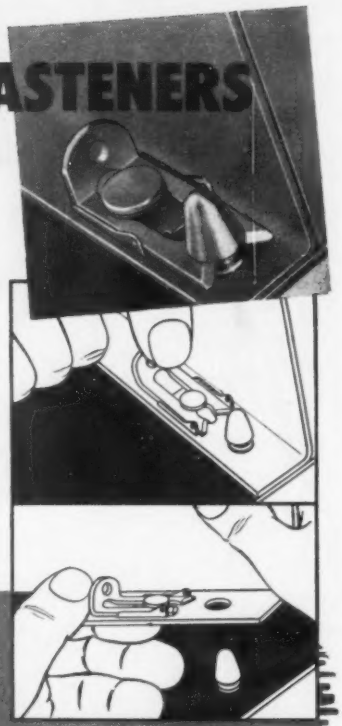

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NEW BOOKS

Electrical Measurements and Their Applications

By Walter C. Michels.

D. Van Nostrand Co., Inc., New York, 1957, 322 p, $6.75.

This book is based on an earlier text entitled "Advanced Electrical Measurements" by Walter C. Michaels, which initially appeared in 1932 and again subsequently in 1941.

The book is in two parts; the first part, comprising nine chapters, deals with fundamental measurement instrumentation, the electrical theory underlying the basic design of the instrument and the parameters that these instrumentation can be used to measure. The text is categorized so that instruments to be treated and the parameters to be measured are discussed in order of ascending frequency.

Part II deals with the application of the basic technique of measurements to the determination of magnetic and nonelectrical parameters including temperature, pressure, force, radiation and sound level.

Actual Emphasis—The title of the book, "Electrical Measurements and Their Applications" is somewhat misleading. A critical reading of the text indicates that methods and techniques of measurement are subordinated to a presentation of basic instrumentation used in electrical measurements. Thus, while most of the information contained in the text is sound, because of the categorization by instrument (e.g., null-type, deflection type, amplifier-type, many basic measurement methods are ignored; hence criticism because of omission or misplaced emphasis may therefore be justified.

To illustrate, less than three pages of text are devoted to the measurement of frequency throughout the entire spectrum while approximately 17 pages are devoted to the measurement of resistance at d-c, in one form or another. Less than one page of text is devoted to the measurement of resistivity and dielectric constant; the word conductivity is not even indexed.

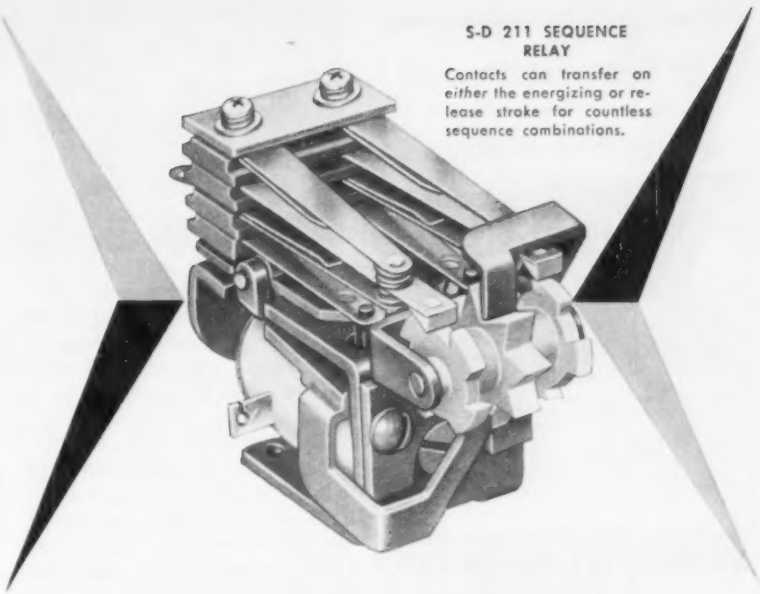
Power measurements, per se, are similarly given only cursory treatment.

Categorization by instrumentation is discarded in Chapters 8 and 9, and the author randomly describes components and instrumentation used at r-f and microwave frequencies. There results a far from complete picture of measurements at these frequencies. It is not clear why the author chooses to devote four pages to a presentation of the impedance characteristics of coaxial cables, while at the same time chooses to ignore such fundamental devices as calorimeters, frequency standards and spectrum analyzers.

Commercial Instruments—In the preface, the author indicates that "no attempt was made to describe and evaluate all of the commercial instruments now available for the laboratory." While this qualification is necessarily true for most texts, the reader is apt to be misled by incomplete descriptions of the instruments that are described. Thus, for example, no mention is made of the attenuator device described on pages 97 through 99 other than in connection with its matching properties. Its use as a level-set device or its application in power and attenuation measurements is not indicated.

Although the slotted-line is described in Chapter 9 in connection with the measurement of vswr and impedance, no mention is made of the use of the slotted line for frequency, attenuation or Q-factor measurements.

In the Oct. 1957 *Proceedings of the IRE*, G. B. Hoadley points out several misleading statements appearing in the text. Others are as follows. On p 215, the author defines a slotted line as ". . . a coaxial line . . .", thus inferring that all slotted lines are coaxial. On p 219, he infers by the sentence ". . . since the inner conductor of the line must be supported at its ends by dielectric beads . . ." that all coaxial slotted lines must be supported by dielectric beads at both ends. This, of course, is not necessarily true. The criteria for differentiating between transmission-type and reaction-type wavemeters,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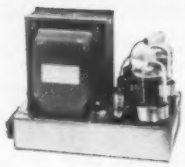

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described on p 227, are not those generally considered and are somewhat vague.

Undergraduate Textbook—Incomplete as the text is, augmented by good instruction, "Electrical Measurements and Their Applications", should prove a useful one for a first undergraduate course in electrical measurements. Its treatment of such instrumentation as galvonometers, voltmeters and ammeters, is quite complete. An excellent feature of the book is that it is liberally supplemented by a series of over 40 laboratory experiments, created around the text material presented. The experiments themselves are well written and provide a nucleus for a good first electrical measurement laboratory course.

Part II of the text comprises an excellent portion of the book and is invaluable in giving the student reader an insight into electrical measurements with which he ordinarily is not familiar. This latter portion of the book is quite modern and includes relatively new material, as evidenced by some of the more recent references.—Moe Wind, *Chief Applications Engineer, Polytechnic Research & Development Co., Inc., Brooklyn, N.Y.*

Elektronenrohren

(Electron Tubes)

By M. J. O. Strutt
Springer-Verlag, Berlin, 1957, 391 *p, DM* 58.50.

This book represents a thoroughly revised third edition of Dr. Strutt's earlier work "Modern Multi-Grid Electron Tubes" whose second edition appeared in 1940. The present work covers a wide variety of tube types with the exception of microwave tubes, including, however, semiconductors and transistors.

Three major divisions cover electrophysical and technical fundamentals; electron interaction with the electromagnetic field; data and characteristics of typical examples of electron tubes.

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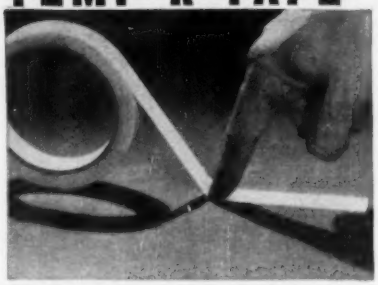

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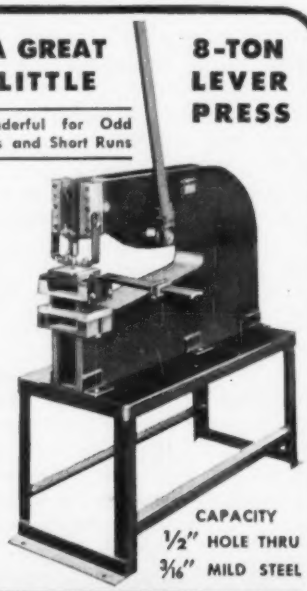

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sion is reviewed including thermionic, photoelectric and secondary, and field emission. A summary of electromagnetic theory is presented including field plotting by relaxation methods and by electrolytic tank plots. The final chapter in this section collects a good deal of useful and very practical information on material and construction techniques including interesting detail on grid construction and glassing techniques.

Tube Types—The second division contains a comprehensive analytical treatment of the major tube types. These are diodes, with high-vacuum and semiconductor types, triodes, including transistors and multigrid tubes. Cathode-ray tubes are discussed after a section on electron optics. The final chapter in this section treats the noise generation in tubes and semiconductors.

The last division presents the characteristics of several typical tubes, triodes, pentodes, thyratrons, transistors, etc. Each of these is shown as an application of the analysis of the earlier sections. The interest is centered on the tube performance and the circuit applications are essentially ignored.

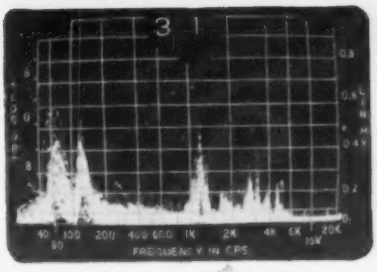
The format and typography are on the high level characteristic of the Springer-Verlag technical publications.

The tube engineer will find this book a mine of useful information and the circuit engineer, too, may find it interesting.—M. ETTENBERG, *Sperry Gyroscope Co. Div. of Sperry Rand Corp., Great Neck, N. Y.*

THUMBNAIL REVIEWS

1956 Supplement to the Bibliography and Abstracts on Electrical Contacts. American Society for Testing Materials, 1916 Race Street, Philadelphia, Pa., 1957, 44 p, $1.75 (paper). Latest supplement to 1952 edition.

Introduction to Operations Research. By C. W. Churchman, R. L. Ackoff and E. L. Arnoff, John Wiley & Sons, Inc., New York, 1957, 648 p, $12.00. Introduction to operations research based on lectures presented at Case Institute of Technology.



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Pulse Notes

Advantages of Air Gap vs. Toroidal Construction in Pulse Transformers

As pointed out in previous Pulse Notes, a pulse transformer wound on a core with an accurately controlled air gap performs more satisfactorily in some applications than one wound on a toroidal (gapless) core.

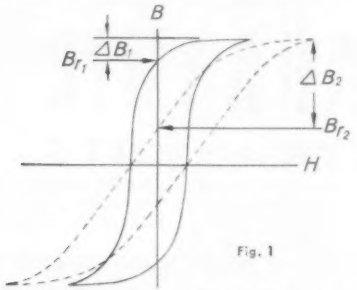

Fig. 1

Consider for a moment the two B-H loops in Figure 1. The loop shown in solid lines is for a toroidal sample of a typical magnetic material used in pulse transformers. The dashed loop is for the same material with an air gap included in the magnetic circuit. In the case of the toroid, removing the pulse magnetizing force causes the core flux to return to the value Br_1*. On the next pulse the total flux swing possible is ΔB_1.

The gapped core, on the other hand, returns to Br_2 which allows the much greater flux swing ΔB_2. Consideration of the voltage-time integral, $ET = NA \int dB$, indicates that a pulse transformer wound on the gapped core passes a pulse of greater area without core saturation than one wound on the gapless or toroidal core.

*This discussion is valid only for cases in which no reverse (resetting) current flows in any of the transformer windings.

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COMMENT

Radar History

The article "Behind the Blair Patent" (Nov. 20, '57, p 21) tells of the recent granting of a patent on pulse-echo radar to retired Colonel William R. Blair. A couple of remarks pertinent to the story may be in order.

Col. Blair's patent describes an early type radar known as SCR-268. Pictures of it, and a description, can be found in ELECTRONICS, Sept. '45, as well as in Vol. I, pp 203-4 of the Radiation Laboratory Series. The SCR-268 employs three antennae and its operation is based on the well-known lobe-switching and pip-matching technique. Due to the shortcomings of this technique, this radar was replaced by the microwave radars, the first and most widely used of which was SCR-584. The work on this radar began in MIT's Radiation Lab in January, 1941. It was described in detail in ELECTRONICS, Nov. '45, Dec. '45 and Feb. '46.

The operation of SCR-584 consists, in the essence, in actuating the sweep of a scope at the moment corresponding to the leading edge of the rectangular envelope of each transmitted pulse, and in determining the time lag from the position of the leading edge of the rectangular envelope of the received rectified pulse.

It would be of interest to point out that the radar circuit which makes use of two rectangular pulses was first described in patent 2,404,527, granted to G. Potapenko of California Institute of Technology. This patent, *Electric Distance Meter*, had been applied for on May 2, 1939; it was kept in the government files under secrecy order until the end of the war and issued on July 23, 1946.

The official statement of Army Signal Engineering Lab calls Blair's patent basic for the pulse-echo method. It may be mentioned that the pulse-echo method had been described in 1926 by G. Breit and M. Tuve of the Carnegie Institution, Washington, D. C., in *Physical Review*, Vol. 28, p 504.

I have no intention to undermine the credit due to Col. Blair for his "pip-matching" SCR-268, but believe the record will be made a bit more clear when the facts mentioned are taken into consideration. I assume Prof. Potapenko's name is not unknown to readers. His picture appeared on the cover of ELECTRONICS, Nov. '33, in connection with his work on centimeter waves. He looks different now, but this cannot be helped.

F. A. UTECHT
FULWIDER, MATTINGLY & HUNTLEY
LONG BEACH, CALIF.

Reader Utecht's analysis is most interesting, and Prof. Potapenko's patent, in the light of everything that's happened in the microwave field since 1939, provided us with a fascinating evening's reading.

Shutter Timer

In your article "Timer Shutter CRT for Single Frame Photos" (Apr. 11, p 83) you mention timers using complicated digital type counters for triggering the single frame picture "on" for the proper duration.

I wish to bring to your attention to a similar device which was built several years back for gating one frame of a television receiver for photographic purposes. Although the particular tv system used 40 frames per second, the gating problem was the same. It was solved by using a relatively simple analog counter operating off the vertical scanning frequency to constantly control the crt gating pulse width.

This device was described in ELECTRONICS, Mar. '50 in an article titled "Single-Frame TV Photography" by Maurice Distel and Allan Gross.

MAURICE DISTEL
U. S. ARMY SIGNAL ENGINEERING LABORATORIES
BELMAR, N. J.

And while we're on the subject of our Apr. 11 issue: a couple of readers have asked if we supply inverting magnifiers for the picture of the pulse analyzer, product of Technical Measurement Corp., that appears on p 145 of that issue. Seems the picture shows the analyzer standing on its head. We checked and discovered that our composing room people were doing headstands when that page was made up. They have been instructed to desist from such unseemly springtime revelry.

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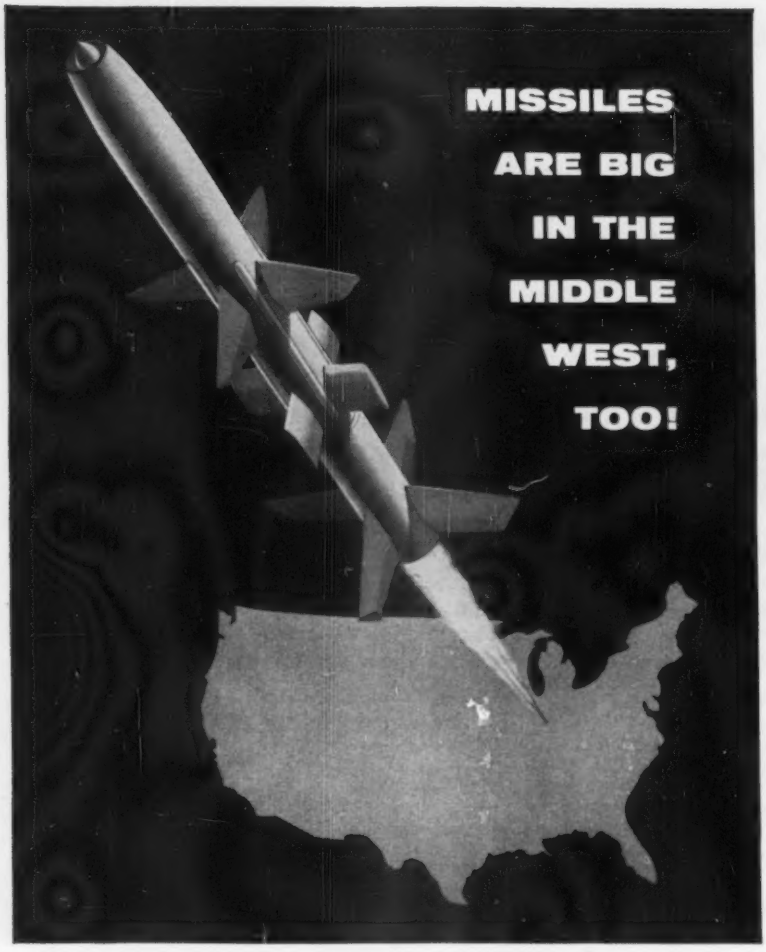

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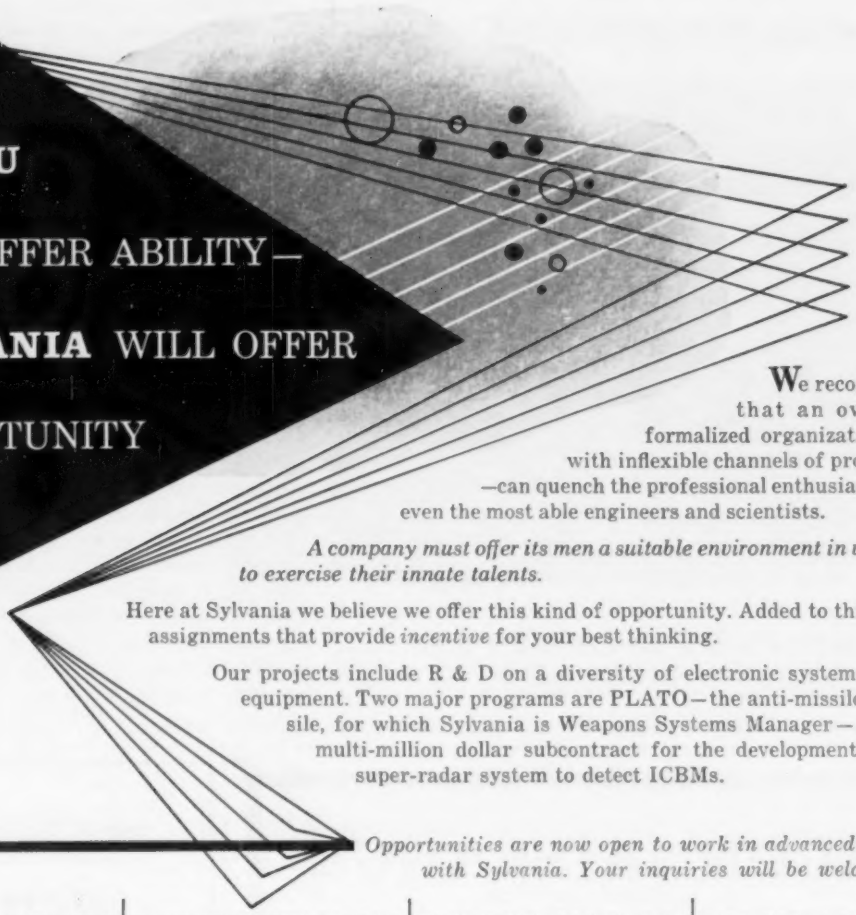

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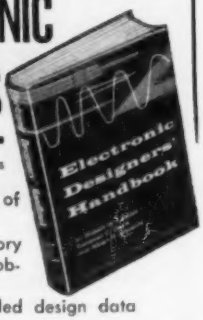

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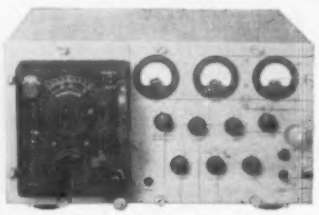

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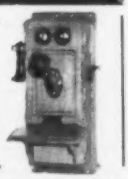

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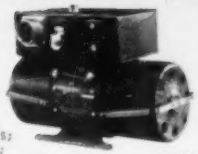

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Output: 115 VAC, 400 cyc.; single phase; 1.53 amp.; 8000 rpm. Input: 13.5 VDC; 29 amp. **$50.00**

PE218 Leland
Output: 115 VAC; single phase pf. 90; 380/500 cycle; 1500 VA. Input: 25-28 VDC; 92 amps.; 8000 rpm.; Exc. Volts 27.5 BRAND NEW **$30.00**

AN 3499 Eicor, Class "A"
Input: 27.5 volts at 9.2 amps. AC. Output: 115 volts, 400 cycles; 3 phase, 100 voltamp; continuous duty. **Price $39.50 each**

MG54D BENDIX INVERTER

Output: 200/115 volts; 400 cycle, single or 3 phase; .80 pf, 250 VA. Input: 28 VDC, 22 amps. **$99.50**

MOTOR GENERATOR TRANSICOIL TYPE 7500

115 volts, 400 cycle. Output 4 volt per 1000 rpm. Motor speed 0-7000 rpm. Gear Train ratio 2000:1. Price **$39.95**

MINNEAPOLIS-HONEYWELL RATE GYRO (Control Flight)

Part no. JG7005A-11 series 9. 115 volts A.C., 400 cycle, single phase. Potentiometer take off resistance 530 ohms. Speed 21,000 r.p.m. Angular momentum 2½ million, CM²/sec. Weight 2 lbs. Dimensions 4-7/32 x 3-29/32 x 3-31/64. Price **$22.50** each

GYRO (flux gate compass)

Mfgd. by Bendix. Part #12002-18 (AN5751-11). Gyro motor 115 volt, 400 cycle, single phase. Speed 20,000 rpm. Leveling accuracy better than ½°. . . . **$15.00 each**

Amplifier. Part #12076-1A for gyro system. **$15.00 each**

Indicator. Part #12005-1D-A1, used with above system. . . . . **$15.00 each**

SELSYNS-SYNCHROS

1CT cont. Trans 90/55V 60 cy.	$34.50
1DG Diff. Gen. 90/90V 60 cy.	34.50
1F Syn. Mtr. 115/90V 60 cy	34.50
1G Gen. 115V 60 cy.	37.50
1HDG	37.50
1HCT	37.50
1HG	37.50
1SF Syn. Mtr. 115/90V 400 cy.	12.50
2J1F1 Gen. 115/57.5V 400 cy.	7.50
2J1F3 Gen. 115/57.5V 400 cy.	10.00
2J1FA1 Gen. 115/57.5V 400 cy.	7.50
2J1G1 57.5/57.5V 400 cy.	5.00
2J1H1 Diff. Gen. 57.5V 400 cy.	7.50
2J5D1 Cont. Trans. 105/55V 60 cy.	17.50
2J5F1 Cont. Trans. 105/55V 60 cy.	17.50
2J5H1 Gen. 115/105V 60 cy.	17.50
2J15M1 Gen. 115/57.5V 400 cy.	17.50
5CT Cont. Trans. 90/55V 60 cy.	34.50
5D Diff. Mtr. 90/90V 60 cy.	34.50
5DDG Diff. Gen. 90/90V 60 cy.	34.50
5F Syn. Mtr. 115/90VAC 60 cy.	34.50
5G Syn. Gen. 115/90VAC 60 cy.	34.50
5HCT Cont. Trans. 90/55V 60 cy.	37.50
5SDG Diff. Gen. 90/90V 400 cy.	12.50
6DG Diff. Gen. 90/90V 60 cy.	25.00
6G Syn. Gen. 115/90VAC 60 cy.	34.50
7G Syn. Gen. 115/90VAC 60 cy.	42.50
C56701 Type 11-4 Rep. 115V 60 cy.	20.00
C69405-2 Type 1-1 Transm. 115V 60 cy.	20.00
C69406 Syn. Transm. 115V 60 cy.	20.00
C69406-1 Type 11-2 Rep. 115V 60 cy.	20.00
C76166 Volt. Rec. 115V 60 cy.	10.00
C78248 Syn. Transm. 115V 60 cy.	12.50
C78249 Syn. Diff. 115V 60 cy.	5.00
C78863 Repeater 115V 60 cy.	7.50
C79331 Transm. Type 1-4 115V 60 cy.	20.00
851 Bendix Autosyn Mtr. 22V 60 cy.	7.50
403 Kollsman Autosyn. Mtr. 32V 60 cy.	7.50
FPE-25-11 Diehl Servo Mfr. 75/115V 60 cy.	19.50
FPE-43-1 Resolver 400 cy.	19.50
FJE-43-9 Resolver 115V 400 cy.	15.00

60 CYCLE AC SERVO MOTOR

with gear reduction

Mfgd. by Diehl. Type FPE-25-11. Low inertia; 75/115 volts; 60 cycle, 2 phase, 4 watt output, 3200 rpm. Gear case: worm gear, spur gear and pinion, reduction ratio 100:1. **$24.50**

TACHOMETER OR RATE GENERATORS

J-36 E.A.D.; 2 volts per 100 rpm; max. rpm 5000 **$22.50**

PM-1 Elinco; 2 volts per 100 rpm; max. rpm 3000 **$17.50**

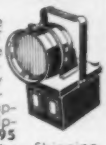
PM-2 Elinco; 2 volts per 100 rpm; max. rpm 3000 **$17.50**

B-35 Elinco; 2 volts per 100 rpm; max. rpm 10,000 **$22.50**

B-68 Elinco; 1.2 V.A.C. per 100 rpm; max. rpm 10,000 **$17.50**

HIGH-QUALITY OPTICAL PARTS

5" Schmidt Ultra Hi-Speed Objective Lens System



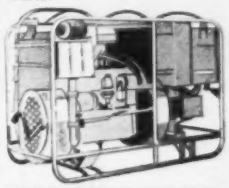
Eastman Kodak infra-red receiver, formerly known as U.S. Navy Snooperscope, Type B, 7" long with 5" SCHMIDT ultra-high speed Objective Lens (approx. f 0.5). Elaborate optical system, many coated lenses. Uses 2 penlight batteries. Govt. cost approx. $300. Factory-new. Shipping wt. 9 lbs. Price **$19.95**

Waterproof Carrying Case, extra. Shipping wt. 3 lbs. Price **$3.00**

Dual purpose U.S.N. floodlight throws strong beam of invisible infra-red rays. With infra-red lens, spare sealed beam lamp, batteries. Shipping wt. 23 lbs. Price **$14.95**

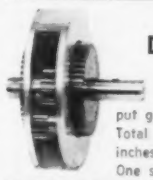
POWER PLANT MODEL EG-107 120/208 V AC, 400 CYCLE

Generator rated at 7.5 kw, 400 cycle, 120/208 volt A.C. Single and 3 phase at 95% pf. Current Drain at rated load 21.7 amps per phase. Also has 28 volt D.C. at 750 watts.



This unit consists of a 4-cylinder water-cooled gasoline engine directly connected to an alternator generator. Complete with control panel. Approximate weight 500 lbs. Price **$495.00**

SIMPLE DIFFERENTIAL



1 to 1 reverse ratio; 48 teeth on input and output gear, 1-1/32 inch diameter. Total outside diameter 1-25/32 inches. Shaft size is ¼ inch. One shaft is 9/16" long; other shaft is 3/16" long. **Stock No. 151** **$5.00**

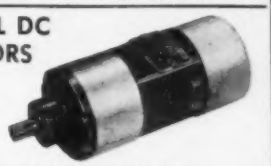
VARIABLE SPEED BALL DISC INTEGRATORS

Forward & Reverse 4-0-4. Input shaft 5/16" dia. x ¾" long. Output shaft 15/64" dia. x 9/16" long. Control shaft 11/64" dia. x 11/16" long. Cast aluminum construction. Approx. size 4½" x 4½" x 4".

No. 146
$17.50 ea.

(All Shafts Ball Bearing Supported)

SMALL DC MOTORS



(approx. size overall 3¾" x 1¼" dia.:)

5067126 Delco PM, 27 VDC, 125 RPM, Governor Controlled	$15.00 ea.
5069600 Delco PM 27.5 VDC 250 rpm	12.50
5069230 Delco PM 27.5 VDC 145 rpm	15.00
5068750 Delco 27.5 VDC 160 rpm w. brake	6.50
5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2")	5.00
5069790 Delco PM, 27 VDC, 100 RPM, Governor Controlled	15.00 ea.
5BA10A118 GE 24 VDC 110 rpm	10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible	10.00
5BA10AJ52 27 VDC 145 rpm reversible	12.50
5BA10AJ50, G.E., 12 VDC, 140 rpm	15.00
206-1001 PM Planetary Gear Reduced Motor with Magnetic Brake. Mfgd. by Air Equipment 26 volts 600 ma 145 rpm	17.50
5BA10FJ33, G.E., 12 VDC, 56 rpm reversible	15.00
806069 Oster series reversible 1/50 h.p. 10,000 rpm. 27.5 VDC 1⅝" x 3½"	5.00
C-28P-1A 27 VDC 1/100 h.p. 7,000 rpm	3.00
7100-B-PM Hansen 24 VDC 160 rpm	7.50
SSFD-6-25 Diehl PM 27.5 VDC 10,000 rpm	4.00
6-volt PM motor mfgd. by Hansen 5,000 rpm 1¼" in dia., 2" long overall	4.00

-CAPACITORS-

4 mfd—200 V . . . . . $.35
Metalized paper bathtub capacitor. Two 2 mfd sections with 3 side terms. Standard dimensions. The perfect crossover network capacitor. Qua. discount.

32 mfd.—600 V $2.98
4 individual 8 mfd sections. Dim 4¾x3¾x3¼. Top Quality Brand.

4 mfd.—400 V . . . . . $.79
Metalized paper bathtub capacitor. Standard dims. and mount.

Mfd	Volts	Price
.001	10KV	5.25
.001	50KV	24.95
.0025	10KV	5.95
.005	25KV	29.95
.01	1500	.55
.01-.01	3000	.40
.012	25KV	12.95
.015	16KV	14.50
.02	8000	4.75
.02	10KV	5.25
.02	20KV	9.95
.025	50KV	32.95
.03	7500	4.25
.04	17KV	7.95
.05	2500	.75
.05	7500	4.25
.05	16KV	7.95
.05-.05	12KV	8.95
2x.05	45KV	60.00
.08	12.5KV	7.95
.1	1500V	.45
.1	2000V	.65
.1	2500V	.69
.1	3000	.65
.1	3000	1.19
.1	4000	1.29
.1	5000	1.49
.1	5000	3.25
.1	7500	.89
.1	7500	4.25
.1	12KV	6.95
.1	15KV	8.95
.1	20KV	9.95
.1	25KV	24.95
.125	27.5	21.95
1.25	100KV	PUR
2x.1	6000	2.29
2x.1	7000	1.35
.2	10KV	8.35
.2	13KV	9.50
.2	15KV	12.50
.2	50KV	69.50
.25	2000	.89
.25	3000	1.45
.25	4000	1.98
.25	6000	.89
.25	15KV	15.95
.25	20KV	19.95
.25	25KV	49.50
.25	32.5KV	53.00
.25	50KV	69.50
.3	2000	.39
2x.25	2000	.89
.4	10KV	10.95
.4	37.5KV	60.00
2x.4	7500	.75
.5	440VAC	.49
.5	600	.45
.5	1500	.59
.5	2000	1.19
.5	2500	1.29
.5	3000	2.98
.5	4000	3.25
.5	5000	3.85
.5	7500	5.75
.5	25KV	38.50
.5-.5	600	.49
.5-.5	9000	8.95
.5-.1	2000	.32
1	115VAC	.32
1	600V	.44
1	1000V	.69
1	1500V	.99
1	2000V	1.75
1	3000V	2.95
1	3600V	2.45
1	4000	4.95
1	5000	6.25
1	6000	8.95
1	7500	7.50
1	7500	14.75
1	10KV	25.95
1	12.5KV	34.50
1	15KV	38.50
1	16	37.50
1	25KV	69.50
1	30KV	PUR
2x1.25	7500	20.00
1.25	330VAC	.49
1.5	25KV	PUR
2	200	.25
2	600	.55
2	1000	.79
2	1000TLA	1.29
2	1500	1.15
2	2000	2.75
2	2500	3.45
2	3000	5.25
2	4000	7.10
2	5000	12.50
2	6000	22.50
2	7500	23.50
2	16KV	59.50
2	10KV	35.95
3	1000	.98
3	2000	1.95
3	4000	8.50
3	15KV	PUR
4	600	.75
4	600TLA	.95
4	330	1.25
4	400	.50
4	500	.65
4	600	.75
4	1000	1.10
4	1000	1.50
4	1500	2.65
4	2000	3.75
4	3000	6.99
4	3000	4.95
4	4000	18.50
4	5000	24.95
4	7500	59.50
4	10KV	74.50
4	15KV	PUR
5	220	1.09
5	330	1.19
5	600	.95
5	1000	1.69
2x5	400	.89
2x5	600	1.19
6	330	1.29
6	600	1.29
6	1000	1.95
6	1500	2.35
7	600	1.35
7	800	1.55
8	330VAC	1.50
8	600	1.25
8	600VAC	2.40
8	1000	2.15
8	1500	3.65
8	2000	7.45
8	2500	9.95
2x8	600	1.89
4x8	600	2.98
9	10KV	PUR
10	400	.65
10	600	.98
10	600	1.19
10	600	1.49
10	1000	3.75
10	1400	2.25
10	1500	4.25
10	2000	6.75
10	2500	10.95
10	2500*	6.25
10	1000	20.95
10	5000	PUR
12	600VAC	4.25
12	1000	2.95
12	2000	7.75
14	660VAC	4.25
15	440VAC	3.25
15	600	2.65
15	1000	4.10
15	5000	PUR
16	660VAC	2.50
20	330VAC	3.25
20	4000	PUR
25	600	3.75
25	2500*	10.95
28	1000	5.95
30	2500	13.50
32	600	2.58
32	9500*	59.50
40	600	5.85
50	100	4.10
50	330VAC	6.50
60	4000	39.50
100	4000	59.50

* Photo Flash

HIGH KVA MICA CAPS

Mfd	Kv	Price
.0000051	6	9.95
.00005	20	29.95
.0001	6	9.95
.000125	10	14.95
.00015	6	10.25
.00015	10	14.95
.00015	20	34.50
.0002	6	9.95
.0002	15	25.50
.00024	6	9.95
.00024	8	9.95
.00025	6	9.95
.00025	30	49.50
.0004	6	9.95
.0005	6	9.95
.0005	20	32.50
.0006	30	52.50
.0008	20	34.50
.001	6	11.95
.001	25	57.60
.00124	15	32.50
.002	8	29.50
.002	10	25.95
.002	15	35.50
.002	20	56.50
.002	30	135.00
.003	30	140.00
.004	6	17.50

Write for quotations on those not listed.

VACUUM CAPACITORS

Mmfd	Kv	Price
12	20	$7.95
12	32	9.95
50	15	8.95

CAPACITORS

Subminiature-Oil filled tubular
Mica Trans. & R'cving. Prices quoted

TYPE "J" POTS

"JU" Linear Taper . . . . . $ .75
"JLU" Linear Taper . . . . . $ .85
"JJ" Linear Taper $2.50

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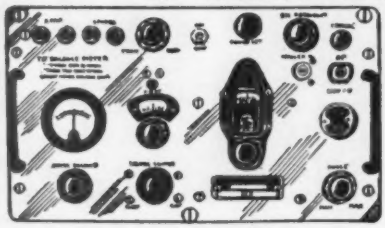

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AN/APR4 complete with five tuning units 38 to 4000 m.c.
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AN/APR10, 2000-4400 m.c.

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NEW TS-147 X BAND SIGNAL GENERATOR

Test Set TS 147 UP is a portable Microwave Signal Generator designed for testing and adjusting beacon equipment and radar systems which operate within the frequency range of 8500 MC to 9000 MC.

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Minimum tube order $25

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TS3A/AP	T35/AP	TS110/AP	TS239C	TF890/1
RF4/AP	TS36/AP	TS111	TS251	APA10
TS12/AP	196A	TS117	TS254	APA38
TA13/AP	TS-45	TS125/AP	TS258	APS3/APS4
TS14/AP	TS46	TS126/AP	TS259	APT2-APT5
TS15	TS47/APR	TS173	TS278	BC152C
TS16	TS61	TS174/AP	TS299	BC788C
TS27	TS62	TS175/AP	TS419	UPM1
TS28	TS69/AP	TS182	TS497B	UPM7
TS33/AP	TS100	TS186	TS535	UPM38
TS34/AP	TS102A/AP	TS204	TS545	UPM13
TS34A/AP	TS108	TS226	TS597	URM64

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ARC-1 Receiver-Transmitter Radio Set, 8-watt-10 channels-100-156 MC 24V DC ea.	125.00
SCR 510 Radio Set 20-27.9 mc, BC-620 Receiver-Transmitter, PE-120 Power supply, CS-79 Case w/tubes complete	12.50
ARC-3 Receivers	150.00
BC-603 Receiver	10.00
BC-604 Transmitter	5.50
BC-683 Receiver	15.00
BC-684 Transmitter	8.50
BC-620 Rec-Trans	6.50
R 77/ARC-3—Certificated	375.00
J68/ARC-3—Certificated	50.00
2 Motors for J 68/ARC-3	40.00
C 118/ARC-3	5.50
C87/ART-13—New	2.75
CU26/ART-13—New	2.75
BC 788 AM—New	50.00
EE8 Field Phones—Used	12.50
RM 29 with GM 38 etc.—New	5.50
BC 611 Handie Talkies—New No Case	9.50
RC 184—New	75.00
TS 35 A/AP with Cables	55.00
TS 45A/AP	17.50
TS 146/UP	50.00
TS 245/TRT	27.50
TS 270/UP	50.00
BD89 SWBD	50.00
TS9—Handset New	3.50
CA355—Capacitors	.20
MC 131 Ringer Coils	.15
EE 65 Test Sets	11.50
F-1 Transmitter Capsules—Used	.25
310 WE Plug—Used	.25
BC 968—Trainer New	69.50
SCR 206 Direction Finder Complete	350.00
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ARC-3 Control Box J 68 with 2 Motors	50.00
APN-1 Sets Complete—New	37.50
R9B Receivers	17.50
R 89 ARN 5 Receivers	37.50
AS 27 A/ARN-5	10.00
RT 22/APX-2—Receiver 28 Tubes	12.50
BC 1000	65.00
HS 30—New	.90
ARN 7 Complete Circuit Diagram	1.00
SCR 269—Instruction Manual	1.50
SCR 284—Instruction Manual	1.50

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5400 pcs .1 mfd
4600 pcs .2 mfd
3500 pcs .14 mfd

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5517	$1.00	5718	$1.75	5963	$1.25
5633	4.00	5719	1.40	5967	9.50
5635	4.00	5744	1.00	5969	9.50
5636	2.40	5751	2.00	5992	6.75
5637	3.00	5763	.90	5993/TE-10	8.00
5639	5.75	5783	1.75	5995	9.75
5641	4.00	5784	4.00	6000	2.00
5643	3.85	5784WA	6.00	NL710/6011	12.00
5644	5.00	5787	3.75	6012	4.00
5645	4.75	5787WA	4.75	6021	1.00
5646	3.75	5814	.40	6073	1.50
5747	3.75	5814A	1.50	6080	3.50
5651	1.25	5814WA	3.00	6111	1.75
5651WA	3.25	5829WA	3.50	6112	4.00
5654/6AK5W		5840	3.00	6130	4.50
	1.25	5840A	4.25	6201/12AT7WA	2.50
5654/6AK5W/6096	2.75	5841	3.75	6211	1.00
5663	.95	5854	1.30	6263	9.50
5670	1.95	5886	3.00	6280/416B	35.00
5670WA	4.00	5894	17.00	6336	11.50
5691	4.75	5896	3.00	6524	11.00
5692	5.00	5898	7.50	8012	1.00
5696	.75	5899	3.25	8013A	4.50
5702WA	3.85	5902	4.80	9002	.45
5703WA	3.85	5932	3.00	9003	.90
5704	1.20	5933	1.50		

RECTIFIERS & REGULATORS

OB2	$ .50	3B28	$4.00	371A	$1.00
OB2WA	2.25	3B29	4.75	371B	1.50
OB3	.50	5R4GY	1.25	575A	10.00
OC3	.50	5R4WGA	3.75	583	5.00
OC3W	2.25	5R4WGY	2.75	869B	30.00
OD3	.50	5Y3WGT	1.30	705A	.65
OD3W	2.25	5X3	2.20	836	1.20
1V	.90	21B	12.00	872A	1.00
2C53	9.00	249B	2.50	876	.75
RX-21	4.50	249C	2.50	878	.50
3B24W	4.25	250R	3.95	VXR2700	6.00
3B24WA	7.80	267B	4.95	991	.32
3B28	92.50	313C	2.25	5931/5U4WG	4.00
		314A	80.00	8013	3.00

KLYSTRONS

1K815XA/X481 B,C,D	$40.00	2K55	$14.00	707B	$1.75
SRX16	100.00	6BL6	90.00	723A/B	6.50
2K25	10.00	6BM6	24.00	726A	6.75
2K28	24.00	6BM6A	27.50	726C,WE	18.00
2K45	25.00	WL417A	28.50	726C,RAY	11.50
2K48	45.00	QK405	2.00	5611	40.00
2K54	14.00		48.00	5981/5650	45.00
				6116	45.00

IGNITRONS AND THYRATRONS

C1K	$6.50	FG154	$9.00	NL1052/5552/	
1C	1.00	VT-158	9.00	FG235A	$82.00
2D21W	.80	FG-271	22.00	2050	1.00
3C45	5.00	323B	3.45	2050W	3.50
4B25	5.00	354A	8.00	5559/FG57	8.00
C5B	1.00	393A	3.35	5560/FG-95	17.00
EL5B	5.00	394AWE	3.00	5796	7.00
5C22	20.00	KU-627	7.00	5948/1754	100.00
C6M/5528	5.00	WL653B	75.00	5966/E36	33.50
FG-32	4.00	NL1051FG-2/1/5551	50.00	6130	4.50
FG105	11.00				

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100-1B86	70-6BM6	200-313C	250-872A
100-2C46	1000-6J4	150-418A	4-885RA
700-2D29	1500-6SH7	700-559A	100-922
500-2E29	300-6SK7GTY	250-574A	3000-957
100-2G21	350-6SK7W	100-581A	2000-1625
300-3AP1	200-6SK7Y	250-587A	300-2050W
50-3C22	600-6Y6G	500-407A	30-5559
200-3C45	300-7CP1	300-408A	300-5702WA
700-3FP7	800-12AT7WA	250-417A	100-5703WA
500-N54	100-12C8	100-701A	2000-5718
500-N55	100-12H6	400-CK-705	300-5719
100-4X150A	600-12SH7	20-714AY	300-5763
300-C5B	400-14J7	400-715B	5000-5814
700-6AB7	400-MK-24	100-723A/B	500-5886
1000-6AC7	100-15E	1000-815	100-5993
100-6AT6	600-15R	200-726C	200-5915
300-6AU6WA	100-VT-158	300-838W	2000-6045
400-6BA6	400267B	16-853	200-6211
200-6BA7	200-272A	100-864	1000-9002

RADAR AND IFF EQUIPMENT

APS-3
APS-4
APS-10
APS-15
APS-19
APN-12 Transponder
APX-6 IFF Equipment
SCR-682
SCR-634

MISCELLANEOUS TUBES

2M21	$25.00	385A	$2.50		
2C51	3.00	WE305A	2.85		
2E26	1.95	WE306A	1.75		
2E22	2.35	WE311A	5.00		
3C22	59.95	WE311B	5.75		
3C33	5.00	WE313C	2.10		
3E29	8.00	WE314A	80.00		
3X2500A3	150.00	327A	3.40		
4C27	8.50	WE328A	3.25		
4CX300A	30.00	WE331A	7.50		
4X150A	18.50	WE337A	5.50		
4X150D	20.00	WE348A	4.00		
4X250B	38.00	WE349A	4.00		
4E27	7.00	WE350A	2.25		
4-250	28.50	WE350B	2.00		
4-125A	18.50	WE354A	15.00		
4-400A	38.50	WE356B	2.95		
4-1000A	125.00	WE359A	1.45		
5D21	5.00	WE368AS	.75		
5D23/RK65	7.00	WE371B	2.00		
6C21	13.50	WE372A	3.00		
15E	1.20	WE373A	3.50		
24G	1.00	WE374A	1.75		
HK24	2.50	381A	5.00		
53A	5.00	WE387A	3.50		
HY65	1.00	WE388A	.85		
1B86	5.00	WE396A	3.00		
100TH	6.00	WE401A	3.95		
C100A	10.00	WE403A	.90		
101D	2.75	WE403B	2.75		
101F	2.75	WE404A	14.00		
104D	2.75	WE407A	3.75		
121A	1.50	WE408A	2.25		
VT-127	1.00	WE412A	3.50		
VT-127A	2.50	WE415A	3.00		
F-128A	7.00	WE416A	25.00		
VT-158	9.50	WE416B	30.00		
HF200	13.00	WE417A	12.00		
201C	13.75	WE418A	17.50		
204A	22.50	WE419A	48.00		
WE205F	4.00	WE421A	6.75		
211	.40	WE422A	7.00		
WE215A	15.00	WE423A	5.00		
220B	55.00	WE426A	2.75		
227A	3.75	WE427A	8.50		
250TH	23.00	WE429A	12.50		
250TL	12.00	WE431A	45.00		
WE251A	42.50	WE436A	10.00		
WE252A	9.50	WE437A	12.00		
WE253A	2.75	WE441A	7.00		
WE254A	2.25	450TH	40.00		
261A	7.00	471A	4.00		
WE262B	5.00	508	190.00		
WE267B	5.00	HK654	15.00		
WE272A	6.50	750TL	30.00		
WE274B	.75	813	8.50		
WE275A	2.75	815	1.25		
WE276D	7.00	829B	3.50		
WE282A	2.00	837	1.25		
WE282B	17.50	919	2.00		
WE287A	2.00	922	1.75		
WE298A	6.75	935	3.50		
WE293A	19.00	1625	.40		
304TH	10.00	ZB3200	60.00		

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3AP1	1.50	5CP11A	8.50
3CP1	1.75	5FP7A	2.50
3DP1S2	12.50	5JP1	8.75
1FP7	1.00	5JP1A	25.00
3GP1	2.00	5NP1	2.00
1W2P1	50.00	7BP1A	15.00
3EP1	1.25	7CP1	2.00
5BP1A	8.50	9LP7	10.00
5BP4	2.25	12DP7	12.00
5CP1	1.75	51UCP11	25.00
5CP1A	7.00	902P1	2.25

MAGNETRONS

2J21A	$4.75	4J33	$45.00
2J22	4.50	4J34	25.00
2J26	4.50	4J35	75.00
2J27	4.50	4J42	25.00
2J28	25.00	4J50	90.00
2J29	25.00	4J51	75.00
2J31	12.25	4J52	50.00
2J32	9.50	4J58	125.00
2J33	28.50	4J64	40.00
2J34	10.00	5J23	75.00
2J37	28.50	QK60	19.50
2J38	28.50	QK62	19.50
2J42	50.00	QK284	95.00
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2J50	12.50	QK367	65.00
2J51	130.00	706AY-GY	9.50
2J51A	148.00	714AY	50.00
2J55	45.00	720AY/CY	32.00
2J56	38.00	725AY/CY	40.00
2J61	9.95	725A	2.50
2J62	4.00	5657	100.00
4J21	35.00	5780	150.00
4J26	45.00	6177	75.00
4J31	125.00		

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All items listed below are in stock, in quantity, and ready for immediate shipment. Prices on request.

APN-9	ILS System
ARC-1 10/20/50 Channels	
ARC-3 10/20/40 Channels	
ARC-19	MN-20
ARC-27	MN-26
ARR-15	MN-31C
ARN-5	MN-36
ARN-6	MN-60B
ARN-7	MN-62A
ARN-12	MR-39B
RDO Receiver	30-1000 Mc...POR
ARN-14	RTA-1B
ART-13A 10/20/40 Channels	
AT-256/ARC	SCR-522
BC-348	SCR-578 (Gibson Girl)
CRT-3 Gibson Girl	SCR-718ABC
	51R3 OMNI Rec.
	171.3 VHF Xmtr

TEST EQUIPMENT

BOONTON NO. 202D Signal Generator	$675.00
TEKRONIX Scope 514D Certified	550.00
GENERAL RADIO GR 1533A High Speed Motion Picture Strobe Light. With or without camera. POR	
TS-3	$275.00
TS-10C	130.00
TS-12	125.00
TS-13	250.00
TS-15A, -B	75.00
TS-23	130.00
TS-28 Oscillator	89.50
TS-35	60.00
TS-45	45.00
TS-62	300.00
TS-67C	1400.00
TS-89	25.00
TS-102	100.00
TS (XA118) APA-59	200.00
TS-110	POR
TS-120	175.00
TS-127	30.00
TS-155B	100.00
TS-155C	250.00
TS-173	POR
TS-197	200.00
TS-258	175.00
TS-268D	75.00
TS-323	350.00
TS-518	150.00
TS-352TU	135.00
TS-382/B	310.00
TS-419	650.00

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212A	300.00
410B	175.00
805A	285.00

APR-1	$200.00
APR-2	70.00
APR-4	700.00
APR-5	250.00
APR-10	300.00
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GR650A	175.00
GR-715A	200.00
I-208	70.00
IE-19	250.00
ME-51U	175.00
SG-55/URM34	400.00
SPERRY GYROSCOPE Remote Flight Control Line Analyzer . . . POR	
OSC, COS80C #3339	75.00
Lab. Jack, Cenco-Lerner #19089	16.00
URM-15	500.00
URM-64	675.00
URM-80 Freq. Meter	900.00

Note: All above test equipment can be certified to meet original specs.

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PE-95

This is a 10 KW 110-220 volt 60 cycle gasoline power plant. The engine used in this unit is a standard Willys Jeep type. Push button starting is incorporated in this unit utilizing a 12 volt battery system. Remote starting may be used up to 200 feet away. This power plant has a large gasoline tank, fuel pump and its own battery charging equipment. This is completely overhauled ready to operate. POR

SATELLITE RECEIVER

This receiver is designed for single frequency reception of modulated radio signals within the frequency range of 30 to 200 mc. At the frequency of 108 mc the receiver has an approx. sensitivity of 4 microvolts for an output of 50 milliwatts. Input voltage is 110 60 cycles. The output was designed for 500 ohms, antenna impedance 70 ohms. This receiver makes a fine satellite monitor or lab type receiver. This receiver was manufactured by Wilcox Electric and is brand new, complete with tubes but less crystal. Price $169.50 ea.

APA-17

This is a direction finder that is used with the APR-1 and APR-4 receivers. This unit provides a visual indication as to the relative bearing of the radio or radar signal that is received on the receiver unit. Power input 110v 400 cycle and 24v DC APA-17B units cover frequencies up to 10,000 mc. POR

ANTENNA PEDESTALS

We have a large inventory of radar type antennas and associated pedestals, such as SCR-584, MPG-2, SCR-545, SA, SK, SC, SCR-582, APG, APS, APQ, and many others. Please send your requirements. Other data on request.

RDO RECEIVER

This Receiver was originally designed as a RADAR Countermeasure unit. The frequency covered by this receiver is 38-4000 Mc. The receiver uses 5 separate RF tuning unit heads to cover the entire range. The IF frequency is 30Mc. Provisions are incorporated in this receiver for the operator to use a Panadapter, Pulse Analyzer or both to view the incoming signal, also included are input and output signal strength meters. Input voltage 110v 60 cycle. All tuning units and receiver are tested before shipment as to operation and calibration. Frequency calibration is approx. 1% from 38-1000 Mc. and 2% from 1000-4000 Mc. POR

MILITARY TYPE TEST EQUIPMENT

TS-3	TS-61	TS-125	TS-247	TS-382
TS-12	TS-62	TS-126	TS-250	TS-419
TS-13	TS-69	TS-146	TS-251	TS-488
TS-14	TS-89	TS-147	TS-258	TS-497
TS-15	TS-100	TS-148	TS-259	TS-545
TS-33	TS-102	TS-155	TS-268	TS-587
TS-34	TS-108	TS-173	TS-270	TS-667
TS-35	TS-111	TS-174	TS-311	BC-221
TS-36	TS-117	TS-175	TS-323	ALL URM
TS-45	TS-120	TS-239	TS-352	ALL UPM

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Darkness throws the switch—turns light on at dusk . . . off at dawn. Fools burglars who watch for signs of an empty house. $10.95

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1 RPM	$3.95	60 RPM	$4.85
2 RPM	2.90	3 RPHr	2.85
4 RPM	3.90	1 RP 2Hr.	2.80
3.6 RPM	3.15	1 RP 12Hr.	3.25

1 RPM—50 Cycles, $1.85
Laboratory Special 1 of Each Motor $25

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Shuts light off automatically almost a minute later. Keeps porch or garage light on after you shut it off. $3.50

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110-V. 60 CY
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1 RPM 230v 60cy	1.00
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2 RPM 230v 60cy	1.00
30 RPM 110v 60cy	2.60
450 RPM, you 450 RPM	1.30
HANSEN Synchron 4 RPM	4.24
CRAMER 4 RPM	4.65
Laboratory Special 1 of Each Motor	$15

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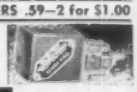

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INDEX TO ADVERTISERS

AC Electronics Division 44
Ace Electronics Associates 128
Aeronautical Communications Equipment Inc. 33
Aerovox Corp. 114
Airpax Products Co. 112
Allegheny Ludlum Steel Corp. 60
Allied Control Company, Inc. 35
Ampex Corporation 41
Arnold Engineering Co., The 10
Arnold Magnetics Corp. 146

Ballantine Laboratories, Inc. 123
Beattie-Coleman, Inc. 175
Beaver Gear Works, Inc. 129
Belden Manufacturing Co. 30
Bendix Aviation Corp., Eclipse-Pioneer Div. 161
Red Bank Div. 36
Bliley Electric 138
Boesch Mfg. Co., Inc. 94
Boonton Radio Corp. 21
Bourns Laboratories 29
Brush Instruments Division of Clevite Corp. 61
Burnell & Co., Inc. 153

CBS Hytron, A Div. of Columbia Broadcasting System, Inc. 93
Caledonia Electronics & Transformer Corp. 129
Cambridge Thermionic Corp. 32H
Celco-Constantine Engineering Laboratories Co. 142
Centralab, A Division of Globe-Union, Inc. 130
Chicago Telephone Supply Corp. 148
Clevite Electronic Components 38
Cohn, Sigmund Mfg. Co., Inc. 145
Connecticut Hard Rubber Co. 160
Coors Porcelain Co. 37
Cornish Wire Co., Inc. 157
Cossor (Canada) Limited 176
Cross Co., H. 148

D & R Ltd. 147
Dano Electric Co. 150
Delco Radio Div. of General Motors 39
DeMornay-Bonardi 58
Dimco-Gray Company 158
Driver-Harris Company 117

Eastern Industries, Inc. 47
Eitel-McCullough, Inc. 31
Electro Instruments Inc. 54
Electro Motive Mfg. Co., Inc. 27
Electronic Associates Inc. 141
Electronic Instrument Co., Inc. (EICO) 140
Electronic Tube Corporation 131
Epsco Inc. 149
Engelhard Industries, Inc. 101
Essex Magnet Wire Division of Essex Wire Corp. 48
Esterline-Angus Company, Inc. 145

Fenwal, Inc. 56A, 56B
Ferroxcube Corp. of America 136
Filtron Co., Inc. 32E

G-L Electronics 125
G. M. Laboratories, Inc. 136
G-V Controls, Inc. 113
Garrett Corporation 104, 105
General Electric Co. Apparatus 23
Magnetic Materials Section 143
Tube Dept. 18A, 18B
General Mills, Mechanical Div. 43
General Radio Co. 3
General Transistor Corp. 103
Giannini & Co., Inc., G. M. 109
Goodrich, B. F. 4
Grant Pulley & Hardware Corp. 40
Gries Reproducer Corp. 137

Harper-Leader, Inc. 150
Haydon Co., Inc., A. W. 151
Helland, A Div. of Minneapolis-Honeywell 34
Helipot Corp., Div. of Beckman Instruments, Inc. 120, 121
Hewlett-Packard Company ..... 24, 25, 2nd Cover
Heyman Manufacturing Co. 139
Hughes Products, a Div. of Hughes Aircraft Co. 15, 140

Illinois Condenser Co. 157
Indiana Steel Products Co. 46
Industrial Instruments, Inc. 104
Industrial Retaining Rings 107
Industrial Timer Corp. 32

Jerrold Electronics Corp. 138
Jet Propulsion Laboratory 32F
Jones Electronics Co., Inc., M. C. 122
Jones Div., Howard B. Cinch 144

Kay Electric Co. 26
Kenyon Transformer Co., Inc. 156
Kepco Laboratories 91
Kintel (Kay Lab) 13
Kleinschmidt Laboratories, Inc. 42
Krohn-Hite Corp. 144

Lambda Electronics Corp. 9
Lampkin Laboratories, Inc. 132
Librascope, Inc. 158
Lockheed Aircraft Corp. 99

Magnecraft Electric Co. 139
Magnetic Amplifiers, Inc. 126
Magnetics, Inc. 87
Malco Tool & Mfg. Co. 154
Mallory and Co., Inc., P. R. 62
Mansol Ceramics Co. 132
Marconi Instruments, Ltd. 133
Marion Electrical Instrument Co. 132
Martin-Denver 156
McGraw-Hill Book Co. 107
McGraw-Hill Publishing Co., Inc. 50, 51
Measurements Corp. 154
Millivac Instruments 135
Monitor Product Co. 155
Multicore Sales Corp. 108

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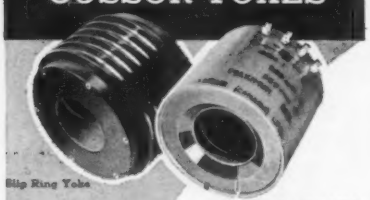

Slip Ring Yoke

Two-Axis Fixed Yoke

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In Ferrite Cores for Speed and Sensitivity
In Non-magnetic Cores for Perfection of Response

Any of Cossor's Three Core Types can be made in single or double axis with single or push-pull windings, and encapsulated for fixed or slip ring (rotating) use.

Normal characteristics of yokes for 1-1/2 in. neck tubes are:

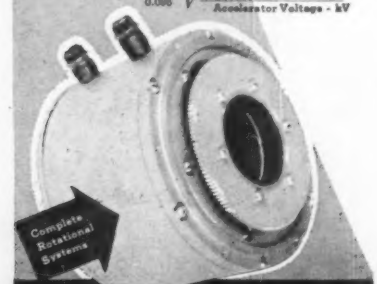
Positional accuracy - the spot position will conform to the yoke current co-ordinates within 0.25% of tube diameter. For deflection angles less than ± 25° better accuracy can easily be achieved.

Memory - 0.5% max. without overswing; 0.1% or less with controlled overswing.

Complete encapsulation in epoxy (stycast) or silicone resins is standard for all Cossor deflection yokes, and is done with special moulding tools ensuring accurate alignment of the yoke axis. When slip rings are added, solid silver rings are mounted in encapsulating resin. The finished slip ring yoke is precision turned to centre bore, and can include bearing mounting surfaces with dimensional tolerances approaching those associable with high quality metal parts.

Settling Time (Micro sec.) = $\frac{}{120\sqrt{\text{Inductance in Henries}}}$

Sensitivity degrees/milliamperes = $0.088\sqrt{\frac{\text{Inductance - millihenries}}{\text{Accelerator Voltage - kV}}}$



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CIRCLE 164 READERS SERVICE CARD

Narda Corporation 32G
Natvar Corporation 55
Northern Radio Co., Inc..... 22
Nothelfer Winding Laboratories, Inc.... 98

Oak Mfg. Co..... 95
Offner Electronics, Inc..... 11
Ohmite Mfg. Co..... 45
Operations Research Office..... 147

Panoramic Radio Products, Inc..... 161
Plymouth Rubber Co., Inc..... 89
Polarad Electronics Corporation...96A, 96B
Pulse Engineering 162

Radio Corporation of America....4th Cover
Radio Engineering Laboratories, Inc.... 53
Radio Engineering Products..... 146
Radio Frequency Laboratories, Inc..... 100
Radiometer 137
Ramo-Wooldridge Corp., The..... 56
Raytheon Mfg. Company..... 6
Revere Corporation of America..... 134
Rotron Manufacturing Co., Inc..... 106

Salon International DE LA Pièce Détachée Electronique 155
Sealectro Corp. 127
Sola Electric Co..... 20
Sorensen & Co., Inc..... 5
Sperry Gyroscope Company, Division of Sperry Rand Corp..... 40
Sprague Electric Co..... 17
Stackpole Carbon Co..... 119
Standard Electric Time Co..... 142
Struthers-Dunn, Inc. 159
Sylvania Electric Products, Inc. 32A, 32B, 32C, 32D, 111

Tensolite Insulated Wire Co., Inc..... 59
Texas Instruments Incorporated...3rd Cover
Trans Electronics, Inc..... 160
Transformers Inc. 57
Transradio, Ltd. 151
Tung-Sol Electric, Inc.....19, 124

Union Switch & Signal Div. of Westinghouse Air Brake Company..... 28

Victory Engineering Corp..... 141
Victoreen Instrument Co..... 115
Vitro Corp. of America..... 96

Washington Aluminum Co., Inc..... 144
Weckesser Co. 132
White Dental Mfg. Co., S. S..... 150
Whitney Metal Tool Co..... 160
Whitso, Inc. 143
Wiley & Sons, Inc., John..... 97

■

Professional Services 169

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES.163-169

EQUIPMENT (Used or Surplus New) For Sale 170-174

ADVERTISERS INDEX

A & M Instrument Service Inc..... 170

Barry Electronics Co..... 172
Bendix Aviation Corp. Bendix Products Div., Missiles..... 164
Blan 174

C & H Sales Co..... 171
CG S Laboratories Inc..... 166
Candee Co., J. J..... 174
Communications Equipment Co..... 170

Fidelity Personnel Service..... 168

General Electric Co..... 163
Goodyear Aircraft Corp..... 164

Harris Transducer Corp..... 172
Henley & Co. 170

International Business Machines Corp... 168

Johns Hopkins University-Applied Physics Laboratory 169

Krantz Co., Harry..... 170

Liberty Electronics 172

M. R. Co..... 174
Martin Co., The..... 167
Monmouth Radio Laboratories..... 172

R. W. Electronics..... 170
Radalab, Inc. 174
Radio Corporation of America..... 167
Radio Research Instrument Co..... 174
Ramo-Wooldridge Corp., The..... 166
Raway Bearing Co..... 170

Stromberg-Carlson Co. 166
Sylvania Electric Products Inc..... 165

TAB— 170
Tallen Co., Inc..... 172
Telephone Engineering Co..... 170

Universal Relay Corp., (Formerly Universal General Corp)..... 172

V & H Radio Electronics..... 173

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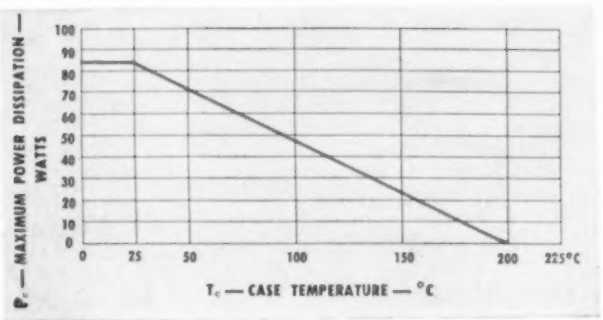

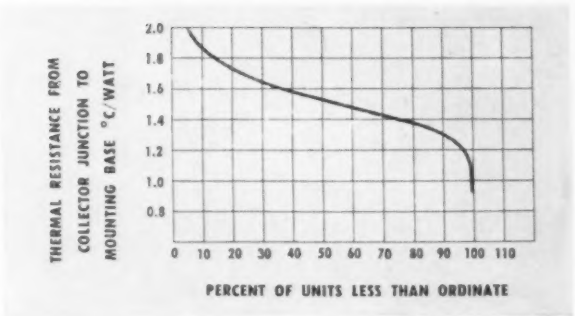

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BV_{EBO}	I_B = 10 mA	−10	—	−10	—	volts
R_{CS}	I_C = 1A, I_B = .2A	—	5	—	10	ohms
V_{BE}	V_{CE} = 10V, I_C = 1.5A	—	8	—	—	volts
V_{BE}	V_{CE} = 10V, I_C = .75A	—	—	—	8	volts
h_{FE}	I_C = 1A, V_{CE} = 10V	10	60	—	—	
h_{FE}	I_C = 1A, V_{CE} = 15V	—	—	10	60	
P_C	T_C = 25°C	—	85	—	85	watts
P_C	T_C = 100°C	—	45	—	45	watts
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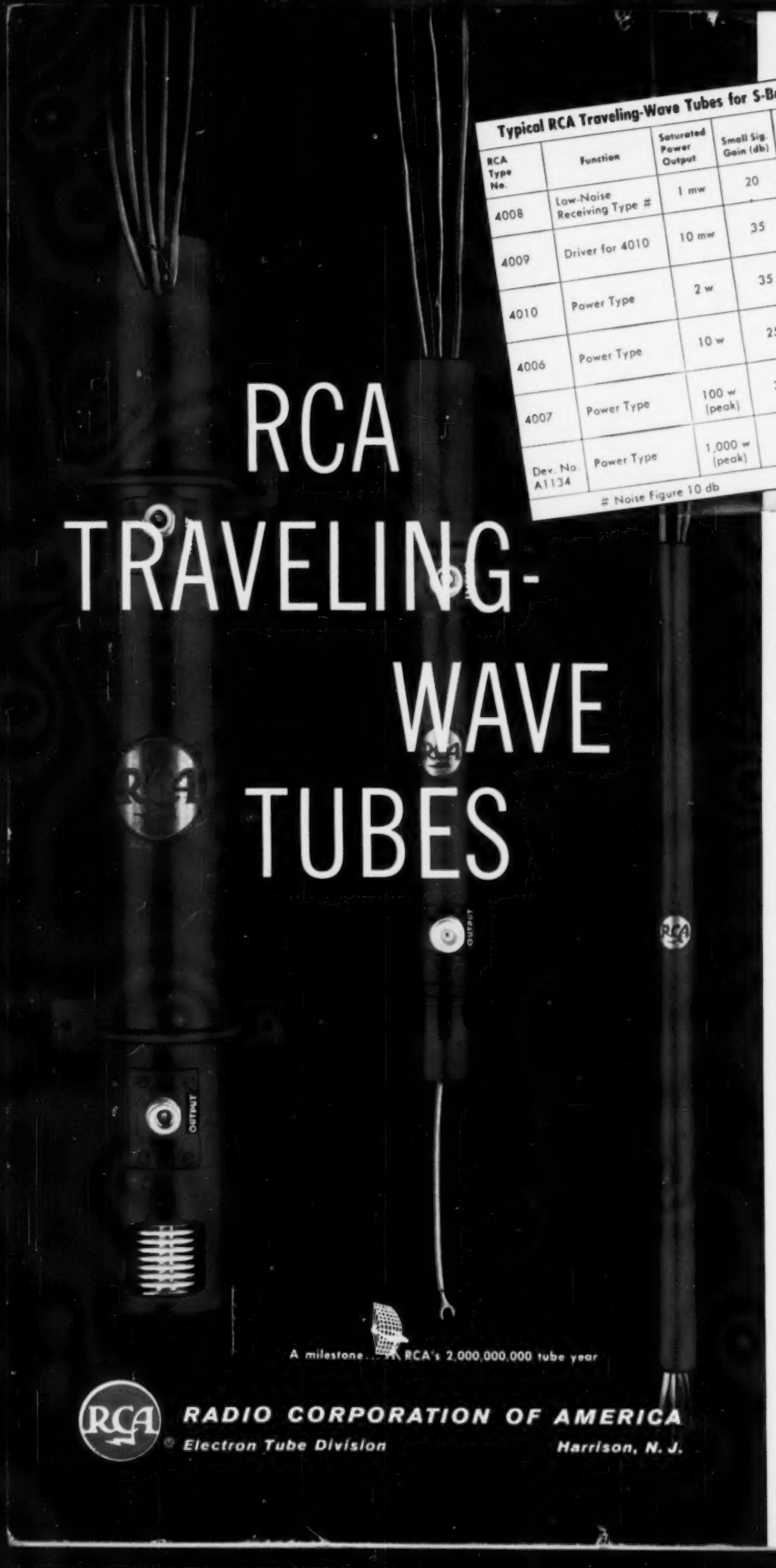

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Typical RCA Traveling-Wave Tubes for S-Band (2000 to 4000 Mc) Operation

RCA Type No.	Function	Saturated Power Output	Small Sig. Gain (db)	Focusing Method	Dia (in.)	Length (in.) Approx.	Weight (lb.)
4008	Low-Noise Receiving Type #	1 mw	20	Light-Weight Solenoid*	•2¼	•16	•10
4009	Driver for 4010	10 mw	35	Integral Periodic Permanent Magnet	1½	14	1½
4010	Power Type	2 w	35	Integral Periodic Permanent Magnet	1½	14	1½
4006	Power Type	10 w	25	Integral Periodic Permanent Magnet	1½	18½	3½
4007	Power Type	100 w (peak)	30	Integral Periodic Permanent Magnet	2½	20	12½
Dev. No. A1134	Power Type	1,000 w (peak)	30	Integral Periodic Permanent Magnet	2½	22	15

Noise Figure 10 db

• Including solenoid available separately

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Pacing the fast-moving advancements in tubes for microwaves, RCA offers designers a comprehensive line of low-noise and power traveling-wave tubes—for any application in the L, S, C, and X bands. These tubes feature a major improvement in traveling-wave tube manufacture: *high uniformity of characteristics maintained through rigid RCA quality control.*

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